

## B.2.10 CALIFORNIA CENTRAL VALLEY STEELHEAD

**Primary contributor: Steve Lindley**  
**(Southwest Fisheries Science Center - Santa Cruz Lab)**

### B.2.10.1 Summary of Previous BRT Conclusions

#### Summary of major risk factors and status indicators

Steelhead were once widespread throughout the Central Valley (CACSS, 1998; Reynolds et al. 1993). Steelhead require cool water in which to oversummer, and much of this habitat is now above impassable dams. Where steelhead are still extant, natural populations subject to habitat degradation, including various effects of water development and land use practices. Concerns of the BRT included extirpation from most of historical range, a monotonic decline in the single available time series of abundance (Table B.2.10.1; Figure B.2.10.1), declining proportion of wild fish in spawning runs, substantial opportunity for deleterious interactions with hatchery fish (including out-of-basin origin stocks), various habitat problems, and no ongoing population assessments. Compared to most chinook salmon populations in the Central Valley, steelhead spawning above Red Bluff Diversion Dam (RBDD) had a fairly strong negative population growth rate and small population size at the time of last census (1993) (Figure B.2.10.2).

Table B.2.10.1. Summary statistics for Central Valley steelhead trend analyses. Numbers in parentheses are 0.90 confidence intervals. Threatened and endangered chinook salmon populations are shown for comparison. Note that for steelhead, the 5-yr geometric mean refers to the period ending in 1993. There is insufficient recent data to calculate a short-term trend in abundance.

Population	5-yr mean	5-yr min	5-yr max	$\lambda$	$\mu$	LT trend	ST trend
Sacramento River steelhead	1,952	1,425	12,320	0.95 (0.90, 1.02)	-0.07 (-0.13, 0.00)	-0.09 (-0.13, -0.06)	NA
Sacramento River winter chinook	2,191	364	65,683	0.97 (0.87, 1.09)	-0.10 (-0.21, 0.01)	-0.14 (-0.19, -0.09)	0.26 (0.04, 0.48)
Butte Creek spring chinook	4,513	67	4,513	1.30 (1.09, 1.60)	0.11 (-0.05, 0.28)	0.11 (0.03, 0.19)	0.36 (0.03, 0.70)
Deer Creek spring chinook	1,076	243	1,076	1.17 (1.04, 1.35)	0.12 (-0.02, 0.25)	0.11 (0.02, 0.21)	0.16 (-0.01, 0.33)
Mill Creek spring chinook	491	203	491	1.19 (1.00, 1.47)	0.09 (-0.07, 0.26)	0.06 (-0.04, 0.16)	0.13 (-0.07, 0.34)

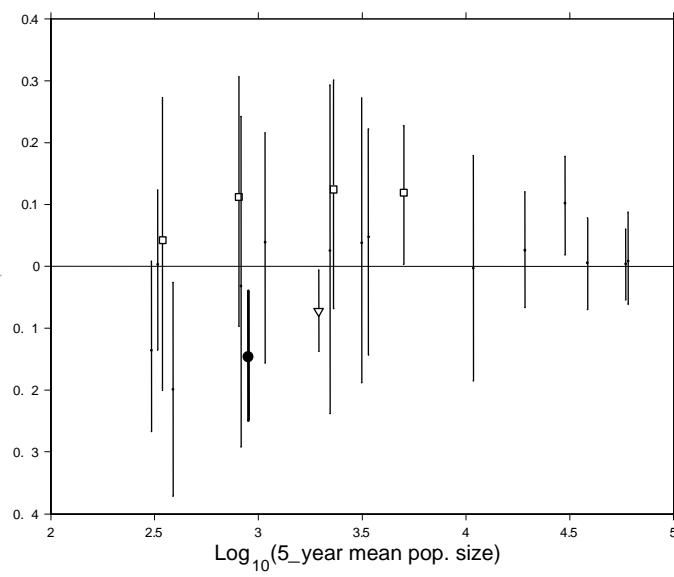


Figure B.2.10.1. Abundance and growth rate of Central Valley salmonid populations. Large filled circle- steelhead above RBDD; open squares- spring chinook; open triangle- winter chinook; small black dots- other chinook stocks (mostly fall runs). Error bars represent central 0.90 probability intervals for  $\mu$  estimates. (Note: as defined in other sections of the status reviews,  $\mu \approx \log [\lambda]$ .)

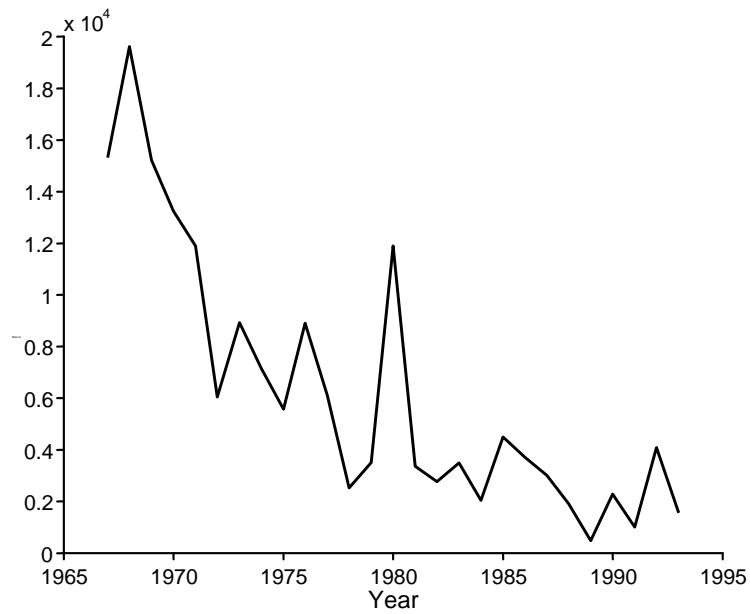


Figure B.2.10.2. Counts of steelhead passing the Red Bluff Diversion Dam fish ladders. These fish include hatchery fish from Coleman NFH.

## **Previous BRT Conclusions**

The BRT previously concluded that the Central Valley ESU was in danger of extinction (Busby et al. 1996), and this opinion did not change in two status review updates (NMFS 1997; NMFS 1998a). The Nimbus Hatchery and Mokelumne River Hatchery steelhead stocks were excluded from the Central Valley ESU (NMFS 1998b).

### **Listing status**

The Central Valley steelhead ESU was listed as Threatened on March 19, 1998.

## **B.2.10.2 New Data and Updated Analyses**

### **Historic distribution and abundance**

McEwan (2001) reviewed the status of Central Valley steelhead. Steelhead probably occurred from the McCloud River and other northern tributaries to Tulare Lake and the Kings River in the southern San Joaquin Valley. McEwan also guessed that more than 95% of historical spawning habitat is now inaccessible. He did not hazard a guess about current abundance. He guessed, on the basis of the fairly uncertain historical abundance estimates of Central Valley chinook reported by Yoshiyama et al. (1998), that between 1 million and 2 million steelhead may have once spawned in the Central Valley. McEwan's estimate is based on the observation that presently, steelhead are found in almost all systems where spring-run chinook salmon occur and can utilize elevations and gradients even more extreme than those used by spring chinook, as well as mid-elevation areas not used by spring chinook. Steelhead should therefore have had more freshwater habitat than spring chinook, and the sizes of steelhead populations should therefore have been roughly comparable those of spring chinook.

### **Current Abundance**

One source of new abundance information since the last status review comes from midwater trawling below the confluence of the Sacramento and San Joaquin Rivers at Chippis Island. This trawling targets juvenile chinook; catches of steelhead are incidental. In a trawling season, over 2,000 20-minute tows are made. Trawling occurred from the beginning of August through the end of June in 1997/98 and 1998/99, after which trawling has occurred year-round. Usually, 10 tows are made per day, and trawling occurs several days per week.

Since the 1998 broodyear, all hatchery steelhead have been ad-clipped. Trawl catches of steelhead provide an estimate of the proportion of wild to hatchery fish, which, combined with estimates of basin-wide hatchery releases, provide an estimator for wild steelhead production:

$$N_w = \frac{C_w}{C_h} N_h \quad (1)$$

where  $N_w$  is the number of wild steelhead,  $C_w$  and  $C_h$  are the total catches of wild and hatchery steelhead, and  $N_h$  is the number of hatchery fish released. The accuracy of the estimate depends on the assumption that hatchery and natural steelhead are equally vulnerable to the trawl gear. In particular, if hatchery fish are more vulnerable to the gear, natural production is underestimated.

Catches of steelhead are sporadic—most sets catch no steelhead, but a few sets catch up to four steelhead. To estimate the mean and variance of  $C_w / C_h$ , the trawl data sets were resampled with replacement 1,000 times. The mean  $C_w / C_h$  ranged from 0.06 to 0.30, and coefficients of variation ranged from 16% to 37% of the means.

From such calculations, it appears that about 100,000-300,000 steelhead juveniles (roughly, smolts) are produced naturally each year in the Central Valley (Table B.2.10.2). If we make the fairly generous assumptions (in the sense of generating large estimates of spawners) that average fecundity is 5,000 eggs per female, 1% of eggs survive to reach Chipps Island, and 181,000 smolts are produced (the 1998-2000 average), about 3,628 female steelhead spawn naturally in the entire Central Valley. This can be compared with McEwan's (2001) estimate of 1 million-2 million spawners before 1850, and 40,000 spawners in the 1960s. Table B.2.10.2 shows the effects of different assumptions about survival on estimates of female spawner abundance.

Table B.2.10.2. Estimated natural production of steelhead juveniles from the Central Valley.  $C_w/C_h$  = ratio of unclipped to clipped steelhead;  $N_r$  = total hatchery releases;  $N_w$  = estimated natural production; ESS = egg-to-smolt survival.

Year	$C_w/C_h$	$N_r$ (millions)	$N_w$ (thousands)	wild female spawners		
				ESS=1%	ESS=5%	ESS=10%
1998	0.300	1.12	336	6,720	1,344	672
1999	0.062	1.51	94	1,872	374	187
2000	0.083	1.38	115	2,291	458	229
average	0.148	1.34	181	3,628	726	363

Another source of information comes from screw trap operations at Knights Landing on the lower Sacramento River, just above the confluence of the Feather River (Snider and Titus 2000a, 2000b, 2000c). Over the period 1995-1999, estimates of the natural production for the areas above Knights Landing averaged 9,800 yearling steelhead outmigrants (range 7260-11,700). This level of production is about 5% of the total production as estimated above, and may be a substantial underestimate due to application of trap efficiency estimates generated from recaptures of marked chinook juveniles, which probably are less able to avoid traps.

Nobriga and Cadrett (2001) analyzed captures of steelhead in trawls at Chipps Island and in fish salvage facilities associated with water diversions in the southern Delta. They computed average daily catch of hatchery and wild steelhead per unit effort, and used these estimates to estimate the percentage of hatchery fish. They found that hatchery steelhead comprised 63-77% of the trawl catch of steelhead at Chipps Island (compared to 77-92% estimated from the resampling method described above), and generally lower percentages in the south Delta, which

is not surprising since the bulk of hatchery production comes out of Sacramento River basin. This alternative analysis of the Chipps Island trawl data suggests that wild steelhead are roughly three-fold more abundant than the resampling analysis discussed above.

## Current Distribution

Recent spawner surveys of small Sacramento River tributaries (Mill, Deer, Antelope, Clear, and Beegum Creeks, Moore 2001) and incidental captures of juvenile steelhead during chinook monitoring (Calaveras, Cosumnes, Stanislaus, Tuolumne, and Merced Rivers) have confirmed that steelhead are widespread, if not abundant, throughout accessible streams and rivers. Much of this information is reviewed by McEwan (2001). Figure B.2.10.3 cartographically summarizes the information on distribution of steelhead in Central Valley streams; details are listed in Table B2.10.3.

CDFG (2003) reported trawl captures of *O. mykiss* at Mossdale on the lower San Joaquin River (below confluence of the Tuolumne, Stanislaus and Merced Rivers). Because the Mossdale area is not suitable habitat for resident *O. mykiss*, these fish are assumed to be steelhead smolts. Between 2 and 30 fish per year were captured in the 1988-2002 period. Rotary screw trap data suggests that the bulk of this production comes from the Stanislaus, although some smolts were captured in the Merced and Tuolumne as well.

## Resident *O. mykiss* considerations

Coastal *O. mykiss* is widely distributed in the Central Valley basin. Roughly half of the trout habitat (by area) in the Central Valley is above dams that are impassable to fish; higher elevation habitats appear to support quite high densities of trout, ranging from a few hundred to a few thousand 4"–6" fish per km (see Appendix B.5.2).

There are several areas of substantial uncertainty that make interpreting this information difficult. First, it is not clear how anadromous and non-anadromous coastal *O. mykiss* interacted in the Central Valley before the dam-building era. In other systems, anadromous and non-anadromous *O. mykiss* forms can exist within populations, while in other systems, these groups can be reproductively isolated despite nearly sympatric distributions within rivers (Zimmerman and Reeves, 2000). Second, hatchery produced *O. mykiss* have been widely stocked throughout the Central Valley, Sierra Nevada and southern Cascades. It is possible that this stocking has had deleterious effects on native wild trout populations, although limited information indicates that native trout populations remain in some areas that have received stocked fish (Nielsen et al. 2000).

We suspect that some coastal *O. mykiss* populations that are above man-made barriers could be part of the Central Valley ESU, because these populations were probably exhibiting some degree of anadromy and interacting with each other on evolutionary time scales prior to barrier construction. Due to a lack of data, we cannot, however, identify any particular resident populations as part of the Central Valley ESU.

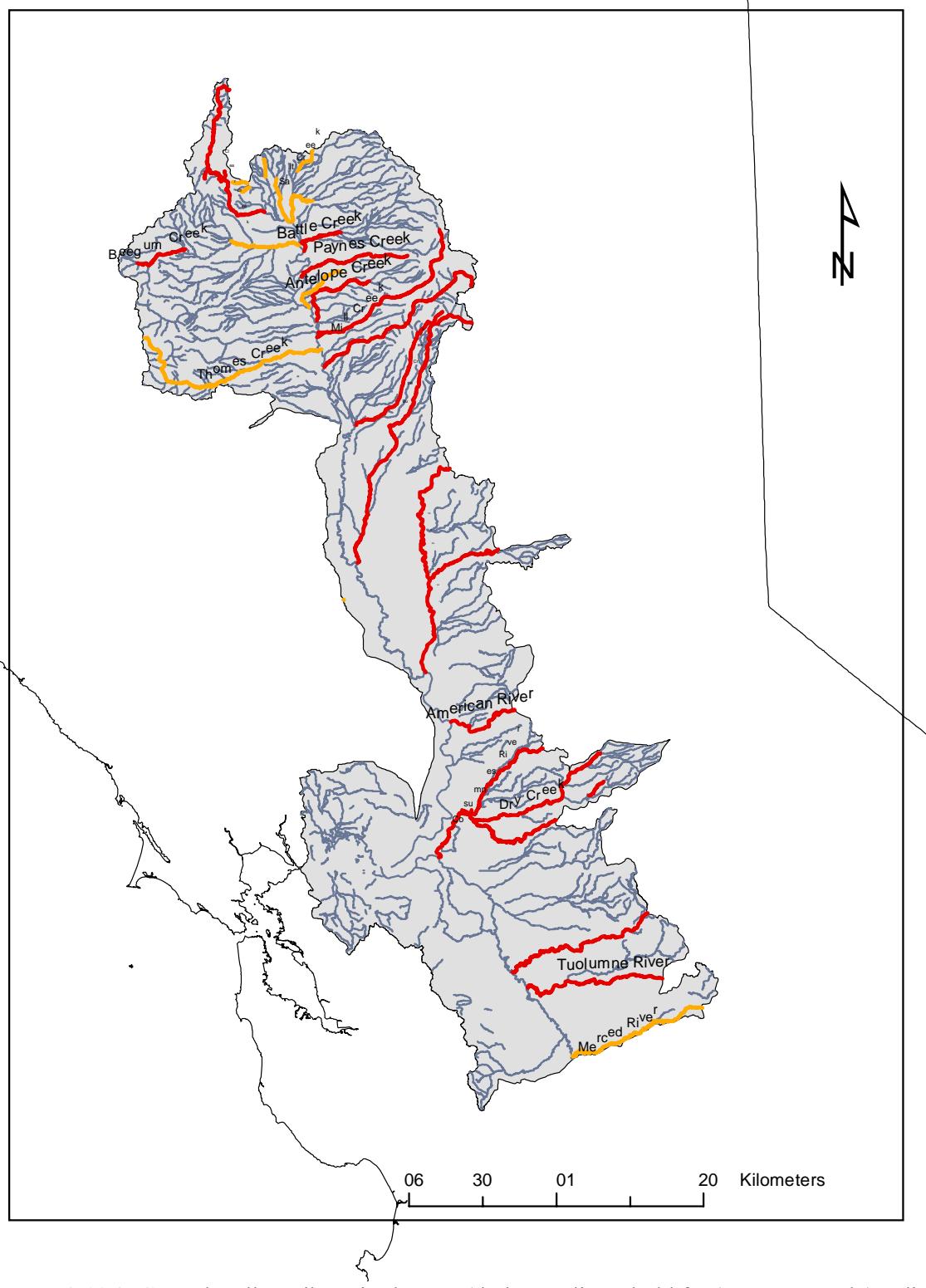
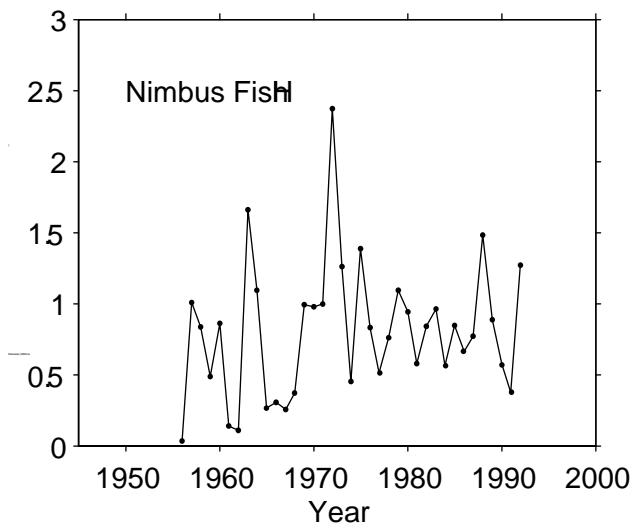
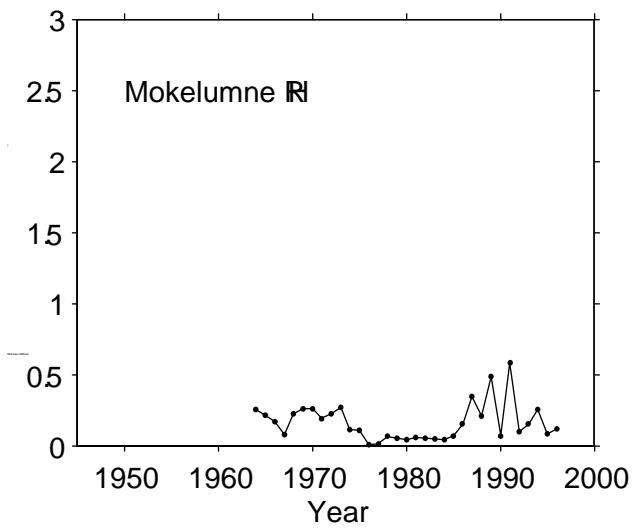
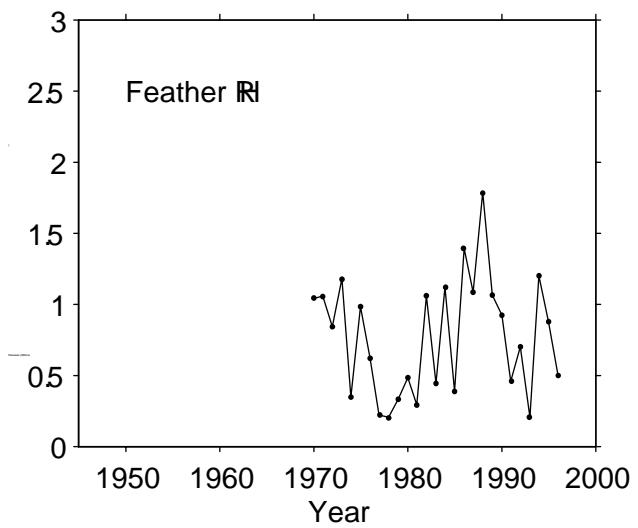
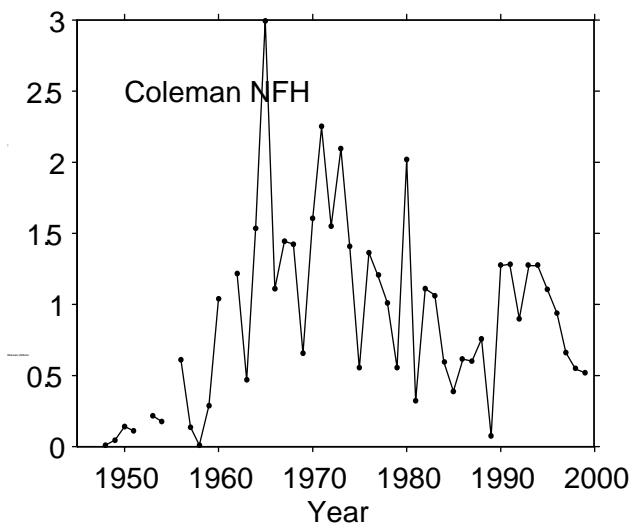


Figure B.2.10.3. Central Valley tributaries known (dark gray lines; bold font) or suspected (medium gray lines; normal font) to be used by steelhead adults. Kerrie Pipal (NMFS Santa Cruz Lab) assembled this information from agency and consultant reports and discussions with CDFG field biologists.

Table B.2.10.3. Summary of distribution information for steelhead in the Central Valley.

System	Tributary presence	Current documented date of presence	Count / Life Stage	Most recent		Comments	Source
				Year	Adults/Juvs		
Sacramento River	Clear Creek	Yes	2001	Adults/Juvs	Snorkel surveys and redd counts, rotary screw traps	Jess Newton (USFWS), personal communication, Aug 2002	
	Rock Creek	Probable	2001	Adults/Juvs	Creek used for spawning	Mike Berry (CDFG), personal communication, Oct 2002.	
Salt Creek	Probable	2001	Adults/Juvs	Possible spawning; non-natal rearing		ibid	
Sulphur Creek	Probable	2001	Adults/Juvs	Creek used for spawning		ibid	
Olney Creek	Probable	2001	Adults/Juvs	Spawning, non-natal rearing		ibid	
Stillwater Creek	Probable	-	-	Non-natal rearing		ibid, Maslin 1998.	
Cow Creek	Probable	1992	-	Suitable habitat, access problems		CDFG 1993	
Cottonwood Creek	Probable	-	-			CDFG 1993	
Beegum Creek	Yes	2001	Adults			Moore 2001.	
South Fork Cottonwood Creek	Possible	-	-	Large populations of 'rainbow trout'		Mike Berry (CDFG), personal communication, Oct 2002.	
Bear Creek	Possible	-	-			CDFG 1993	
Battle Creek	Yes	2002	-			Kier & Associates 2001. Jess Newton (USFWS), personal communication, Aug 2002.	
Paynes Creek	Yes	2002	Adults	Self-sustaining population unlikely		Mike Berry (CDFG), personal communication, Oct 2002.	
Antelope Creek	Yes	2001	Adults + redds			Moore 2001.	
Mill Creek	Yes	2001	Adults + redds	Small numbers counted.		Moore 2001.	
Elder Creek	Possible	No recent surveys	-	Resident trout present		CDFG 1993	

Thomes Creek	Probable	1969 & 2002	-	Used by chinook, "trout" observed	Puckett 1969, Killam 2002, Mike Berry (CDFG), personal communication, Oct 2002.
Deer Creek	Yes	2001	Adults + redds		Moore 2001
Rice Creek	Yes	1998	Juveniles		Maslin 1998
Big Chico Creek	Yes	-	-		CDFG 1993
Butte Creek	Yes	2000	-	Report confirms steelhead presence, no details.	USFWS 2000
Feather River	Yes	1998	YOY + Juvs	Screw trap captures	CDWR 1998
Yuba River	Yes	1998	-	Report confirms steelhead presence, no details.	IEP 1998
Deer Creek (Yuba trib)	Yes	1993	Adults	Dive survey	StreamNet database
Dry Creek	Yes	-	-	Secret and Miners Ravines	R. Titus, CDFG
American River	Yes	2002	Adults + redds	Counted redds, estimated number of adults based on redd counts.	Hannon and Healey 2002.
Putah Creek	Yes	2000	-	Very small numbers of adult steelhead make P. Moyle (UC Davis) public communication their way to the base of Monticello dam	<a href="http://wdsroot.ucdavis.edu/clients/pchtr/book/04_Lake_Solano/04_04_moyle_fish_lowpc.html">http://wdsroot.ucdavis.edu/clients/pchtr/book/04_Lake_Solano/04_04_moyle_fish_lowpc.html</a>
San Joaquin River	Cosumnes River	Yes	1995	-	Nobriga 1995
Mokelumne River	Yes	2001	Adults + juveniles	Smolts salvaged from drying pools	Workman 2001
Calaveras River	Yes	2001	Adults + juveniles	Several reports list presence, but do not give Gonzalo Castillo, USFWS personal any details, angler reports/photos.	Kennedy 2002.
Stanislaus River	Yes	2001	YOYs & 1+		
Tuolumne River	Yes	2001	Juvs	Incidental rotary screw trap captures	CDFG 2003
Merced River	Possible	2002	Juvs	Incidental rotary screw trap captures, large trout caught be anglers, enter hatchery	David Vogel (NRC), personal communication, June 2002. Michael Cozart (Merced River Hatchery), personal communication, Sept 2002.



restoration actions on Butte Creek. There is still a nearly complete lack of steelhead monitoring in the Central Valley.

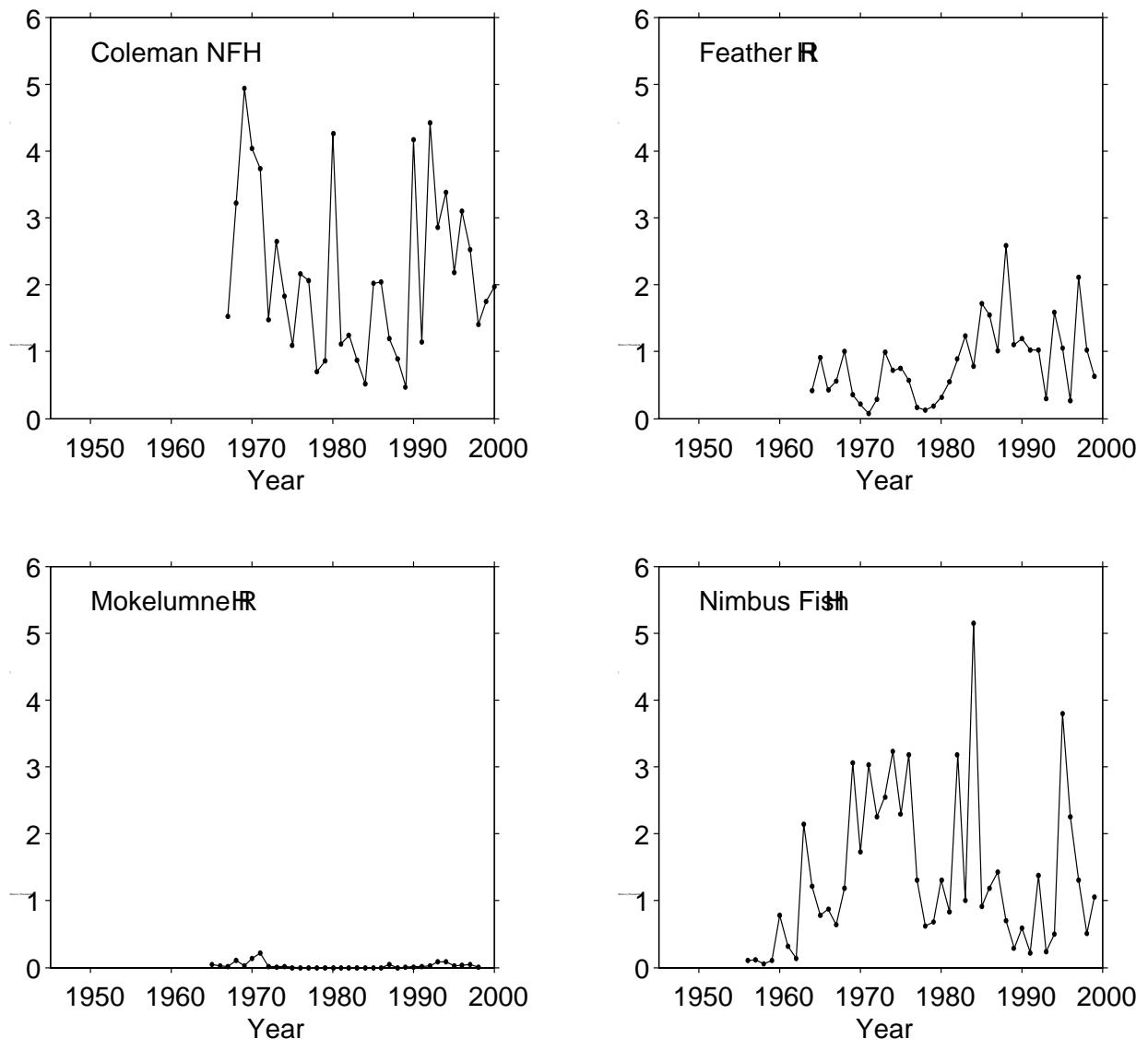


Figure B.2.10.5. Returns of steelhead to Central Valley hatcheries.

## B.3 STEELHEAD BRT CONCLUSIONS

The ESA (Sec. 3) allows listing of “species, subspecies, and distinct population segments.” The option to list subspecies is not available for Pacific salmon, since no formally recognized subspecies exist. However, a number of subspecies have been identified for *O. mykiss*, including two that occur in North America and have anadromous populations. According to Behnke (1992), *O. mykiss irideus* (the “coastal” subspecies) includes coastal populations from Alaska to California (including the Sacramento River), while *O. mykiss gairdneri* (the “inland” subspecies) includes populations from the interior Columbia, Snake and Fraser Rivers. Both subspecies thus include populations within the geographic range of this updated status review, but both also include northern populations outside the geographic range considered here. The BRT did not attempt to evaluate extinction risk to *O. mykiss* at the species or subspecies level; instead, we evaluated risk at the distinct population segment (ESU) level, as for the other species considered in this report.

### **Snake River steelhead ESU**

A majority (over 70%) of the BRT votes for this ESU fell in the “likely to become endangered” category, with small minorities falling in the “danger of extinction” and “not likely to become endangered” categories (Table B.3.1). The BRT did not identify any extreme risks for this ESU but found moderate risks in all the VSP categories (mean risk matrix scores ranged from 2.5 for spatial structure to 3.2 for growth rate/productivity) (Table B.3.2). The continuing depressed status of B-run populations was a particular concern. Paucity of information on adult spawning escapements to specific tributary production areas makes a quantitative assessment of viability for this ESU difficult. As indicated in previous status reviews, the BRT remained concerned about the replacement of naturally produced fish by hatchery fish in this ESU; naturally produced fish now make up only a small fraction of the total adult run. Again, lack of key information considerably complicates the risk analysis. Although several large production hatcheries for steelhead occur throughout this ESU, relatively few data exist regarding the numbers and relative distribution of hatchery fish that spawn naturally, or the consequences of such spawnings when they do occur.

On a more positive note, sharp upturns in 2000 and 2001 in adult returns in some populations and evidence for high smolt-adult survival indicate that populations in this ESU are still capable of responding to favorable environmental conditions. In spite of the recent increases, however, abundance in most populations for which there are adequate data are well below interim recovery targets (NMFS 2002).

Based on the provisional framework discussed in the general Introduction to this report, the BRT assumed as a working hypothesis that resident fish below historical barriers are part of this ESU, while those above long-standing natural barriers (e.g., in the Palouse and Malad Rivers) are not. Recent genetic data suggest that native resident *O. mykiss* above Dworshak Dam on the North Fork Clearwater River should be considered part of this ESU, but hatchery rainbow trout that have been introduced to that and other areas would not. The BRT did not attempt to resolve the ESU status of resident fish residing above the Hell’s Canyon Dam complex, as little new information is available relevant to this issue. However, Kostow (2003) suggested that,

based on substantial ecological differences in habitat, the anadromous *O. mykiss* that historically occupied basins upstream of Hells Canyon (e.g., Powder, Burnt, Malheur, Owyhee rivers) may have been in a separate ESU. For many BRT members, the presence of relatively numerous resident fish mitigated the assessment of extinction risk for the ESU as a whole.

## **Upper Columbia River steelhead ESU**

A slight majority (54%) of the BRT votes for this ESU fell in the “danger of extinction” category, with most of the rest falling in the “likely to become endangered” category (Table B.3.1). The most serious risk identified for this ESU was growth rate/productivity (mean score 4.3); scores for the other VSP factors were also relatively high, ranging from 3.1 (spatial structure) to 3.6 (diversity) (Table B.3.2). The last 2-3 years have seen an encouraging increase in the number of naturally produced fish in this ESU. However, the recent mean abundance in the major basins is still only a fraction of interim recovery targets (NMFS 2002). Furthermore, overall adult returns are still dominated by hatchery fish, and detailed information is lacking regarding productivity of natural populations. The ratio of naturally produced adults to the number of parental spawners (including hatchery fish) remains low for upper Columbia steelhead. The BRT did not find data to suggest that the extremely low replacement rate of naturally spawning fish (estimated adult: adult ratio was only 0.25-0.3 at the time of the last status review update) has improved substantially.

Based on the provisional framework discussed in the general Introduction to this report, the BRT assumed as a working hypothesis that resident fish below historical barriers are part of this ESU, while those above long-standing natural barriers (e.g., in the Entiat, Methow, and perhaps Okanogan basins) are not. Resident fish potentially occur in all areas in the ESU used by steelhead. Case 3 resident fish above Conconully Dam are of uncertain ESU affinity. The BRT did not attempt to resolve the ESU status of resident fish residing above Grand Coulee Dam, as little new information is available relevant to this issue. Possible ESU scenarios for these fish include 1) they were historically part of the ESU and many of the remnant resident populations still are part of this ESU; 2) they were historically part of the ESU but no longer are, due to either introductions of hatchery rainbow trout or rapid evolution in a novel environment; or 3) they were historically part of a separate ESU. For many BRT members, the presence of relatively numerous resident fish mitigated the assessment of extinction risk for the ESU as a whole.

## **Middle Columbia River steelhead ESU**

A slight majority (51%) of the BRT votes for this ESU fell in the “likely to become endangered” category, with a substantial minority (49%) falling in the “not likely to become endangered” category (Table B.3.1). The BRT did not identify any extreme risks for this ESU but found moderate risks in all the VSP categories (mean risk matrix scores ranged from 2.5 for diversity to 2.7 for abundance) (Table B.3.2).

This ESU proved difficult to evaluate for two reasons. First, the status of different populations within the ESU varies greatly. On the one hand the abundance in two major basins, the Deschutes and John Day, is relatively high and over the last five years is close to or slightly

over the interim recovery targets (NMFS 2002). On the other hand, steelhead in the Yakima basin, once a large producer of steelhead, remain severely depressed (10% of the interim recovery target), in spite of increases in the last 2 years. Furthermore, in recent years escapement to spawning grounds in the Deschutes River has been dominated by stray, out-of-basin (and largely out-of-ESU) fish—which raises substantial questions about genetic integrity and productivity of the Deschutes population. The John Day is the only basin of substantial size in which production is clearly driven by natural spawners. For the other major basin in the ESU (the Klickitat), no quantitative abundance information is available. The other difficult issue centered on how to evaluate contribution of resident fish, which according to Kostow (2003) and other sources are very common in this ESU and may greatly outnumber anadromous fish. The BRT concluded that the relatively abundant and widely distributed resident fish mitigated extinction risk in this ESU somewhat. However, due to significant threats to the anadromous component the majority of BRT members concluded the ESU was likely to become endangered.

Historically, resident fish are believed to have occurred in all areas in the ESU used by steelhead, although current distribution is more restricted. Based on the provisional framework discussed in the general Introduction to this report, the BRT assumed as a working hypothesis that resident fish below historical barriers are part of this ESU, while those above long-standing natural barriers (e.g., in Deschutes and John Day basins) are not. Case 3 resident fish above Condit Dam in the Little White Salmon; above Pelton and Round Butte Dams (but below natural barriers) in the Deschutes; and above irrigation dams in the Umatilla Rivers are of uncertain ESU status.

## **Lower Columbia River steelhead ESU**

A large majority (over 79%) of the BRT votes for this ESU fell in the “likely to become endangered” category, with small minorities falling in the “danger of extinction” and “not likely to become endangered” categories (Table B.3.1). The BRT found moderate risks in all the VSP categories, with mean risk matrix scores ranging from 2.7 for spatial structure to 3.3 for both abundance and growth rate/productivity) (Table B.3.2). All of the major risk factors identified by previous BRTs still remain. Most populations are at relatively low abundance, and those with adequate data for modeling are estimated to have a relatively high extinction probability. Some populations, particularly summer run, have shown higher returns in the last 2-3 years. The Willamette Lower Columbia River TRT (Myers et al. 2002) has estimated that at least four historical populations are now extinct. The hatchery contribution to natural spawning remains high in many populations.

Based on the provisional framework discussed in the general Introduction to this report, the BRT assumed as a working hypothesis that resident fish below historical barriers are part of this ESU, while those above long-standing natural barriers (e.g., in upper Clackamas, Sandy, and some of the small tributaries of the Columbia River Gorge) are not. Case 3 resident fish above dams on the Cowlitz, Lewis, and Sandy Rivers are of uncertain ESU status.

## **Upper Willamette River steelhead ESU**

The majority (over 76%) of the BRT votes for this ESU fell in the “likely to become endangered” category, with small minorities falling in the “danger of extinction” and “not likely to become endangered” categories (Table B.3.1). The BRT did not identify any extreme risks for this ESU but found moderate risks in all the VSP categories (mean risk matrix scores ranged from 2.6 for diversity to 2.9 for both spatial structure and growth rate/productivity) (Table B.3.2). On a positive note, after a decade in which overall abundance (Willamette Falls count) hovered around the lowest levels on record, adult returns for 2001 and 2002 were up significantly, on par with levels seen in the 1980s. Still, the total abundance is small for an entire ESU, resulting in a number of populations that are each at relatively low abundance. The recent increases are encouraging but it is uncertain whether they can be sustained. The BRT considered it a positive sign that releases of the “early” winter-run hatchery population have been discontinued, but remained concerned that releases of non-native summer-run steelhead continue.

Because coastal cutthroat trout is a dominant species in the basin, resident *O. mykiss* are not as widespread here as in areas east of the Cascades. Resident fish below barriers are found in the Pudding/Molalla, Lower Santiam, Calapooia, and Tualatin drainages, and these would be considered part of the steelhead ESU based on the provisional framework discussed in the general Introduction. Resident fish above Big Cliff and Detroit Dams on the North Fork Santiam and above Green Peter Dam on the South Fork Santiam are of uncertain ESU affinity. Although no obvious physical barrier separates populations upstream of the Calapooia from those lower in the basin, resident *O. mykiss* in these upper reaches of the Willamette basin are quite distinctive both phenotypically and genetically and are not considered part of the steelhead ESU.

## Northern California steelhead ESU

The majority (74%) of BRT votes were for “likely to become endangered,” with the remaining votes split about equally between “in danger of extinction” and “not warranted” (Table B.3.1). Abundance and productivity were of some concern (scores of 3.7; 3.3 in the risk matrix); spatial structure and diversity were of lower concern (scores of 2.2; 2.5); although at least one BRT member gave scores as high as 4 for each of these risk metrics (Table B.3.2).

The BRT considered the lack of data for this ESU to be a source of risk due to uncertainty. The lack of recent data is particularly acute for winter runs. While there are older data for several of the larger river systems that imply run sizes became much reduced since the early twentieth century, there are no recent data suggesting much of an improvement.

Based on the provisional framework discussed in the general Introduction to this report, the BRT assumed as a working hypothesis that resident fish below historical barriers are part of the Northern California Coast Steelhead ESU, while those above long-standing natural barriers are not. Historically, resident fish are believed to have occurred in all areas in the ESU used by steelhead, although current distribution is more restricted. Resident fish above recent (usually man-made) barriers--including Robert W. Matthews Dam on the Mad River and Scott Dam on the Eel River--but below natural barriers are of uncertain ESU affinity. In this ESU, the inclusion of resident fish would not greatly increase the total numbers of fish, and the resident fish have not been exposed to large amounts of hatchery stocking.

## **Central California Coast steelhead ESU**

The majority (69%) of BRT votes were for “likely to become endangered,” and another 25% were for “in danger of extinction” (Table B.3.1). Abundance and productivity were of relatively high concern (mean score of 3.9 for each, with a range of 3 to 5 for each), and spatial structure was also of concern (score 3.6) (Table B.3.2). Predation by pinnipeds at river mouths and during the ocean phase was noted as a recent development posing significant risk.

There were no time-series data for this ESU. A variety of evidence suggested the largest run in the ESU (the Russian River winter steelhead run) has been reduced in size and continues to be reduced in size. Concern was also expressed about the populations in the southern part of the range of the ESU--notably populations in Santa Cruz County and the South Bay area.

Based on the provisional framework discussed in the general Introduction to this report, the BRT assumed as a working hypothesis that resident fish below historical barriers are part of the Central California Coast Steelhead ESU, while those above long-standing natural barriers are not. Historically, resident fish are believed to have occurred in all areas in the ESU used by steelhead, although current distribution is more restricted. Resident fish above recent (usually man-made) barriers--including Warm Springs Dam on Dry Creek, Russian River; Coyote Dam on the East Fork Russian River; Seeger Dam on Lagunitas Creek; Peters Dam on Nicasio Creek, Lagunitas Creek; and Standish Dam on Coyote Creek--but below natural barriers are of uncertain ESU affinity. In this ESU, an estimated 22% of historical habitat is behind recent barriers. The only relevant biological information about the populations above these barriers pertains to Alameda Creek, and suggests that some but not all populations above Dam 1 are genetically similar to populations within the ESU. For some BRT members, the presence of resident fish mitigated the assessment of extinction risk for the ESU as a whole.

## **South-Central California Coast steelhead ESU**

The majority (68%) of BRT votes were for “likely to become endangered,” and another 25% were for “in danger of extinction” (Table B.3.1). The strongest concern was for spatial structure (score 3.9; range 3-5), but abundance and productivity were also a concern (Table B.3.2). The cessation of plants to the ESU from the Big Creek Hatchery (Central Coast ESU) was noted as a positive development, whereas continued predation from sport fishers was considered a negative development.

New data suggests that populations of steelhead exist in most of the streams within the geographic boundaries of the ESU; however, the BRT was concerned that the two largest river systems—the Pajaro and Salinas basins—are much degraded and have steelhead runs much reduced in size. Concern was also expressed about the fact that these two large systems are ecologically distinct from the populations in the Big Sur area and San Luis Obispo County, and thus their degradation affects spatial structure and diversity of the ESU. Much discussion centered on the dataset from the Carmel River, including the effects of the drought in the 1980s, the current dependence of the population on intensive management of the river system, and the vulnerability of the population to future droughts.

Based on the provisional framework discussed in the general Introduction to this report, the BRT assumed as a working hypothesis that resident fish below historical barriers are part of the South-Central California Coast Steelhead ESU, while those above long-standing natural barriers are not. Historically, resident fish are believed to have occurred in all areas in the ESU used by steelhead, although current distribution is more restricted. Resident fish above recent (usually man-made) barriers--including San Antonia, Nacimiento, and Salinas dams on the Salinas River; Los Padres Dam on the Carmel River; Whale Rock Dam on Old Creek; and Lopez Dam on Arroyo Grande Creek--but below natural barriers are of uncertain ESU affinity. In this ESU, little of the historical habitat is behind recent barriers and most of that on the Salinas River. For some BRT members, the presence of resident fish mitigated the assessment of extinction risk for the ESU as a whole.

### **Southern California steelhead ESU**

The majority (81%) of BRT votes were for “in danger of extinction,” with the remaining 19% of votes being for “likely to become endangered” (Table B.3.1). Extremely strong concern was expressed for abundance, productivity, and spatial structure (mean scores of 4.8, 4.3, and 4.8, respectively, in the risk matrix), and diversity was also of concern (mean score of 3.6) (Table B.3.2).

The BRT expressed concern about the lack of data on this ESU, about uncertainty as to the metapopulation dynamics in the southern part of the range of the ESU, and about the fish’s nearly complete extirpation from the southern part of the range. Several members were concerned and uncertain about the relationship between the population in Sespe Canyon, which is supposedly a sizeable population, and the small run size passing through the Santa Clara River, which connects the Sespe to the ocean. There was some skepticism that flows in the Santa Maria River were sufficient to allow fish passage from the ocean to the Sisquoc River, another “stronghold” of *O. mykiss* in the ESU.

Based on the provisional framework discussed in the general Introduction to this report, the BRT assumed as a working hypothesis that resident fish below historical barriers are part of the South California Steelhead ESU, while those above long-standing natural barriers are not. Historically, resident fish are believed to have occurred in all areas in the ESU used by steelhead, although current distribution is more restricted. Resident fish above recent (usually man-made) barriers--including Twitchell Dam on the Cuyama River; Bradbury Dam on the Santa Ynez River; Casitas Dam on Coyote Creek, Ventura River; Matilija Dam on Matilija Creek, Ventura River; Santa Felicia Dam on Piru Creek, Santa Clara River; and Casitac Dam on Casitac Creek, Santa Clara River--but below natural barriers are of uncertain ESU affinity. In this ESU, a large portion of the original area is behind barriers, and the few density estimates that are available from this ESU indicate that the inclusion of area above recent barriers would substantially increase the number of fish in the ESU. Due to the extremely low numbers of anadromous fish in this ESU, it is possible that above-barrier populations contribute a significant number of fish to the below-barrier population by spill over. For some BRT members, the presence of resident fish mitigated the assessment of extinction risk for the ESU as a whole.

## **California Central Valley steelhead ESU**

The majority (66%) of BRT votes were for “in danger of extinction”, and the remainder was for “likely to become endangered” (Table B.3.1). Abundance, productivity and spatial structure were of highest concern (4.2-4.4), although diversity considerations were of significant concern (3.6) (Table B.3.2). All categories received a 5 from at least one BRT member.

The BRT was highly concerned by the fact that what little new information was available indicated that the monotonic decline in total abundance and in the proportion of wild fish in the ESU was continuing. Other major concerns included the loss of the vast majority of historical spawning areas above impassable dams, the lack of any steelhead-specific status monitoring, and the significant production of out-of-ESU steelhead by the Nimbus and Mokelumne River fish hatcheries. The BRT viewed the anadromous life-history form as a critical component of diversity within the ESU and did not place much importance on sparse information suggesting widespread and abundant *O. mykiss* populations in areas above impassable dams. Dams both reduce the scope for expression of the anadromous life-history form, thereby greatly reducing the abundance of anadromous *O. mykiss*, and prevent exchange of migrants among resident populations, a process presumably mediated by anadromous fish.

Based on the provisional framework discussed in the general Introduction to this report, the BRT assumed as a working hypothesis that resident fish below historical barriers are part of the California Central Valley Steelhead ESU, while those above long-standing natural barriers are not. Historically, resident fish are believed to have occurred in all areas in the ESU used by steelhead, although current distribution is more restricted. Resident fish above recent (usually man-made) barriers--including Shasta Dam on the Upper Sacramento River; Whiskeytown Dam on Clear Creek; Black Butte Dam on Stony Creek; Oroville Dam on the Feather River; Englebright Dam on the Yuba River; Camp Far West Dam on the Bear River; Nimbus Dam on the American River; Commanche Dam on the Mokelumne River; New Hogan Dam on the Calaveras River; Goodwin Dam on the Stanislaus River; La Grange Dam on the Tuolumne River; and Crocker Diversion Dam on the Merced River--but below natural barriers are of uncertain ESU affinity. As noted above, collectively these dams have isolated a large fraction of historical steelhead habitat, and resident fish above the dams may outnumber ESU fish from below the dams.

Table B.3.1. Tally of FEMAT vote distribution regarding the status of 10 steelhead ESUs reviewed. Each of 16 BRT members allocated 10 points among the three status categories.

ESU	Danger of Extinction	Likely to Become Endangered	Not Likely to Become Endangered
Snake River <sup>1</sup>	14	103	23
Upper Columbia <sup>1</sup>	75	62	3
Middle Columbia <sup>1</sup>	1	71	68
Lower Columbia <sup>2</sup>	10	110	30
Upper Willamette <sup>2</sup>	7	106	37
Northern California	18	119	23
Central California Coast	40	111	9
South Central California	40	109	11
Southern California	129	31	0
Central Valley	106	54	0

<sup>1</sup> Votes tallied for 14 BRT members

<sup>2</sup> Votes tallied for 15 BRT members

Table B.3.2. Summary of risk scores (1 = low to 5 = high) for four VSP categories (see section "Factors Considered in Status Assessments" for a description of the risk categories) for the 10 steelhead ESUs reviewed. Data presented are means (range).

ESU	Abundance	Growth Rate/Productivity	Spatial Structure and Connectivity	Diversity
Snake River	3.1 (2-4)	3.2 (2-4)	2.5 (1-4)	3.1 (2-4)
Upper Columbia	3.5 (2-4)	4.3 (3-5)	3.1 (2-4)	3.6 (2-5)
Middle Columbia	2.7 (2-4)	2.6 (2-3)	2.6 (2-4)	2.5 (2-4)
Lower Columbia	3.3 (2-5)	3.3 (3-4)	2.7 (2-4)	3.0 (2-4)
Upper Willamette	2.8 (2-4)	2.9 (2-4)	2.9 (2-4)	2.6 (2-3)
Northern California	3.7 (3-5)	3.3 (2-4)	2.2 (1-4)	2.5 (1-4)
Central California Coast	3.9 (3-5)	3.9 (3-5)	3.6 (2-5)	2.8 (2-4)
South Central California	3.7 (2-5)	3.3 (2-4)	3.9 (3-5)	2.9 (2-4)
Southern California	4.8 (4-5)	4.3 (3-5)	4.8 (4-5)	3.6 (2-5)
Central Valley	4.4 (4-5)	4.3 (4-3)	4.2 (2-5)	3.6 (2-5)

## B.4 REFERENCES

- Adams, P. 2000. Memorandum to Rodney McInnis: Status review update for the steelhead northern California Evolutionarily Significant Unit. U.S. Dep. Commer., National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz/Tiburon Laboratory, Tiburon, California.
- AFS (American Fisheries Society). 1991. Minutes of southern California steelhead meeting, US Fish and Wildlife Service Office, Ventura, California, January 22, 1991. Am. Fish. Soc., California-Nevada Chapter, Environmental Concerns Committee, 9 p. (Available from Trout Unlimited of California, 2530 San Pablo Ave., Suite D, Berkeley, CA 94702).
- Alley, D. W., and Associates. 1994. Comparison of juvenile steelhead densities in 1981 and 1994 with estimates of total numbers of mainstem juveniles and expected numbers of adults returning to the San Lorenzo River, Soquel Creek and Corralitos Creek, Santa Cruz County, California. City of Santa Cruz Water Department, City of Watsonville Water Department Lompico County Water District San Lorenzo Valley Water District and Soquel Creek Water District. Project # 122-01, 123-01, 124-01, 125-01, Brookdale, California .
- Alley, D. W., and Associates. 1995. Comparison of juvenile steelhead densities in 1981, 1994 and 1995 with an estimate of juvenile population size in the mainstem San Lorenzo River, with expected numbers of adults returning form juveniles reared in the mainstem river, Santa Cruz County, California. City of Santa Cruz Water Department, San Lorenzo Valley Water District and Lompico County Water District. Project # 135-01, 136-01. Brookdale, California.
- Alley, D. W., and Associates. 1997. Comparison of juvenile steelhead densities in 1981 and 1994-96 in the San Lorenzo River and tributaries, with an estimate of juvenile population size in the mainstem river and expected adult returns from that production, Santa Cruz County, California. City of Santa Cruz Water Department and the San Lorenzo Valley Water District. Project # 143-01, 144-01. Brookdale, California.
- Alley, D. W., and Associates. 1998. Comparison of juvenile steelhead densities in 1981 and 1994-97 in the San Lorenzo River and tributaries, Santa Cruz County, California; with an estimate of juvenile population size in the mainstem river and expected adult returns. City of Santa Cruz Water Department, and San Lorenzo Valley Water District. Project # 150-01. Brookdale, California .
- Alley, D. W., and Associates. 1999. Comparisons of juvenile steelhead densities, population estimates and habitat conditions for the San Lorenzo River, Santa Cruz County, California, 1994-98; with predicted adult returns. City of Santa Cruz Water Department, Santa Cruz County Environmental Planning and the San Lorenzo Valley Water District. Project #150-02. Brookdale, California.

- Alley, D. W., and Associates. 2000. Comparisons of juvenile steelhead densities, population estimates and habitat conditions for the San Lorenzo River, Santa Cruz County, California, 1995-99; with an index of adult returns. City of Santa Cruz Water Department, Santa Cruz County Environmental Planning and the San Lorenzo Valley Water District. Project #150-03. Brookdale, California.
- Alley, D. W., and Associates. 2002. Comparison of juvenile steelhead densities in 1997 through 2001, in the San Lorenzo River and tributaries, Santa Cruz County, California; with an estimate of juvenile population size and an index of adult returns. City of Santa Cruz Water Department, San Lorenzo Valley Water District and NMFS. Project # 150-06. Brookdale, California .
- Alley, D. W., and Associates. 2002. Comparison of juvenile steelhead densities in 1997 through 2001, in the San Lorenzo River and tributaries, Santa Cruz County, California; with an estimate of juvenile population size and an index of adult returns. City of Santa Cruz Water Department, San Lorenzo Valley Water District and NMFS. Draft report Project # 150-06. Brookdale, California .Anonymous. 1994. Oregon salmon and steelhead catch data, 1981-93. Unpublished.
- Anonymous. 1995. 1995 Stock status review for winter steelhead, Mid-Willamette district, NW region.
- Anonymous. 1997. ODFW Mid-Willamette Fish District unpublished files: winter steelhead Foster dam counts, Minto trap counts and run size estimates; Molalla R. spring chinook run size estimates through 1997.
- Anonymous. 1998. Portland General Electric fish facility reports. Unpublished StreamNet Reference.
- Anonymous. 1998. ODFW Columbia River Management unpublished files: Willamette Falls fish passage 1946-97.
- Barnhart, R. A. 1986. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest)--steelhead. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.60), 21 p.
- Behnke, R. J. 1992. Native trout of western North America. Am. Fish. Soc. Monog. 6, 275 p. American Fisheries Society, Bethesda, MD.
- Berg, L (ed.). 2001. Yakima Subbasin Summary (Draft). Northwest Power Planning Council, Portland, OR.
- Berry, R. L. 1978. Salmon and steelhead sport catch statistics, 1978. Unpublished.
- Bjornn, T. C. 1978. Survival, production, and yield of trout and chinook salmon in the Lemhi River, Idaho. Univ. Idaho, Coll. For., Wildl. Range Sci. Bull. 27, 57 p.

- Boughton, D. A. and H. Fish. MS. The current regional distribution of steelhead (*Oncorhynchus mykiss*) in Southern California. Available from NOAA Fisheries, Southwest Science Center, 110 Shaffer Road, Santa Cruz, CA.
- Brown, L. R. and P. B. Moyle. 1981. The impact of squawfish on salmonid populations: a review. N. Amer. J. Fish. Man. 1: 104 – 111.
- Brown, L. R. and P. B. Moyle. 1997. Invading species in the Eel River, California: successes, failures, and relationships with resident species. Environmental Biology of Fishes 49: 271 – 291.
- Bryson, D. 2001. Draft Imnaha Subbasin Summary. Prepared for the Northwest Power Planning Council. 241 p.
- Burgner, R. L., J. T. Light, L. Margolis, T. Okazaki, A. Tautz, and S. Ito. 1992. Distribution and origins of steelhead trout (*Oncorhynchus mykiss*) in offshore waters of the North Pacific Ocean. Int. North Pac. Fish. Comm. Bull. 51, 92 p.
- Busby, P. J., O. W. Johnson, T. C. Wainwright, F. W. Waknitz, and R. S. Waples. 1993. Status review for Oregon's Illinois River winter steelhead. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-10, 85 p.
- Busby, P. J., T. C. Wainwright, G. J. Bryant, L. Lierheimer, R. S. Waples, F. W. Waknitz, and I. V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon, and California. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-27, 261p.
- CACSS (California Advisory Committee on Salmon and Steelhead). 1988. Restoring the balance. Calif. Dep. Fish Game, Sacramento, CA. 84 p.
- Cardenas, M. 1996. Upper Sisquoc River survey. CDFG Report.
- CDFG (California Department of Fish and Game). 1965. California fish and wildlife plan. Volume III supporting data: part B, inventory salmon-steelhead and marine resources. California Department of Fish and Game, Sacramento, California. 679 p.
- CDFG (California Department of Fish and Game). 1979. Nelson Creek wild trout management plan. California Department of Fish and Game, Sacramento, CA, 27 p.
- CDFG (California Department of Fish and Game). 1982. 1982 status report of California wild and scenic rivers salmon and steelhead fisheries. Calif. Dept. Fish Game, Sacramento, CA, 159 p.
- CDFG (California Department of Fish and Game). 1995. Letter to M. Schiewe for the ESA Administrative Record for west coast steelhead, dated 30 March 1995, 10 p. plus

attachments. (Avail. from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)

CDFG (California Department of Fish and Game). 2000. Fishery management and evaluation plan, south-central California coast evolutionarily significant unit, steelhead, draft document. CDFG, Fisheries Programs Branch, 1416 Ninth Street, Sacramento, CA.

CDFG (California Department of Fish and Game). 2000. Fishery management plan for the Upper Sacramento River (Box Canyon Dam to Lake Shasta) 2000 to 2005. California Department of Fish and Game, Sacramento, CA, 52 p.

CDFG (California Department of Fish and Game). 2001. Fishery management plan, Central Valley, California Evolutionary Significant Unit, Steelhead. California Department of Fish and Game, Sacramento, CA, 59 p.

CDFG (California Department of Fish and Game). 2001a. Fishery management and evaluation plan, Central California Coast Evolutionarily Significant Unit, draft.

CDFG (California Department of Fish and Game). 2001b. Fishery management and evaluation plan, South-Central California Coast Evolutionarily Significant Unit, draft.

CDFG (California Department of Fish and Game). 2002. 2002 Freshwater sportfishing regulations booklet. Available from CDFG, 1416 Ninth Street, Room 1320, Sacramento, CA 95814. 70 pp.

CDFG (California Department of Fish and Game). 2003. Letter from D. Marston (CDFG) to M. Martinez (NMFS), dated January 9, 2003.

Chilcote, M. W. 1998. Conservation Status of Steelhead in Oregon. Information Report 98-3. Oregon Department of Fish and Wildlife.

Chilcote, M. W. 2001. Conservation Assessment of Steelhead Populations in Oregon. Oregon Department of Fish and Wildlife. Portland, OR.

Chilcote, M. W. 2002. Spreadsheet with 2002 Oregon steelhead escapement updates.

Cichosz, T., D. Saul, A. Davidson, W. Warren, D. Rollins, J. Willey, T. Tate, T. Papanicolaou and S. Juul. 2001. Clearwater Subbasin Summary. Draft submitted to the Northwest Power Planning Council. Nov. 2001. 477 p.

Clanton, D. A. and J. F. Jarvis. 1946. Memorandum to Bureau of Fish Conservation re: field inspection trip to the Matilija-Ventura watershed in relation to the construction of the proposed Matilija Dam, dated 8 May 1946. Calif. Dep. Nat. Resources., Div. Fish Game, 3 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.).

- Comstock, R. 1992. Santa Clara River steelhead restoration assessment. US Fish and Wildlife Service, Western Washington Fishery Resource Office, Olympia, Washington, 10 pp. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.).
- Cooney, T. 2001. Upper Columbia River steelhead and spring chinook salmon quantitative analysis report. Part 1: run reconstructions and preliminary analysis of extinction risks. National Marine Fisheries Service. Hydro Program. Technical Review Draft
- Cramer, D. 2002a. Portland General Electric - Clackamas winter steelhead adults. Portland General Electric. Data delivered via e-mail from Kathryn Kostow, Oregon Dept of Fish and Wildlife.
- Cramer, D. 2002b. Portland General Electric - sandy winter steelhead adults. Portland General Electric. Data delivered via e-mail from Kathryn Kostow, Oregon Dept of Fish and Wildlife.
- Cramer, S. P., and 12 co-authors. 1995. The status of steelhead populations in California in regards to the Endangered Species Act. Document prepared for Association of California Water Agencies, 167 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.).
- Cramer, S., R. Beamesderfer, P. Monk, K. Witty, A. Kalin, B. Lister & C. Akerman. 2002. Mid-Columbia steelhead trout population viability assessment. S.P. Cramer & Assoc. Progress Rept. Submitted to NMFS. April 2002.
- CRFMP TAC (Columbia River Fisheries Management Plan Technical Advisory Committee). 1991. Summer steelhead. In Columbia River fish management plan: 1991 All species review. Technical Advisory Committee, U.S. v. Oregon. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)
- Currens, K. P., S. L. Stone, and C. B. Schreck. 1987. A genetic comparison of rainbow trout (*Salmo gairdneri*) above and below Izee Falls in the John Day River, Oregon. Oregon Coop. Fish. Res. Unit Genet. Lab. Rep. 87(2), 34 p.
- Currens, K. P., C. B. Schreck, and H. W. Li. 1990. Allozyme and morphological divergence of rainbow trout (*Oncorhynchus mykiss*) above and below waterfalls in the Deschutes River, Oregon. Copeia 1990:730-746.
- Deinstadt, J. M., and Berry, M. A. 1999. California wild trout program, Hat Creek wild trout management plan, 1998 - 2003. California Department of Fish and Game, Sacramento, CA, 51 p.
- Engblom, S. 1997. Compilation report for the 1996-97 Santa Ynez River Memorandum of understanding. SYRTAC.

- Engblom, S. 1999. Compilation report for the 1998-99 Santa Ynez River Memorandum of understanding.
- Engblom, S. 2001. 2001 Lower Santa Ynez River steelhead studies – annual report, Santa Barbara County, California.
- Entrix. 1995. Historical steelhead run in the Santa Ynez River. Project No. 374100, prepared for Price Postel and Parma, 200 E. Carillo St., Santa Barbara, CA 93102.
- Everest, F. H. 1973. Ecology and management of summer steelhead in the Rogue River. Oregon State Game Commission, Fishery Research Report 7, Corvallis, 48 p.
- Foerster, R. E. 1947. Experiment to develop sea-run from land-locked sockeye salmon (*Oncorhynchus nerka kennerlyi*). J. Fish. Res. Board Can. 7(2):88-93.
- Fulton, L. A., and R. E. Pearson. 1981. Transplantation and homing experiments on salmon, *Oncorhynchus* spp., and steelhead trout, *Salmo gairdneri*, in the Columbia River system: fish of the 1939-1944 broods. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC 12, 97 p.
- Gephart, L. & D. Nordheim (eds) 2001. Tucannon Subbasin Summary. Prepared for the Northwest Power Planning Council. 222 pages.
- Gorman, L. 2001. Hood steelhead at Powerdale dam. StreamNet Excel workbook provided to Paul McElhaney from Leah Gorman 10/16/2001. This workbook is based on data provided by Rod French to ODFW/NMFS in the Microsoft Word file Data2000.doc on 7/31/2001.
- Grass, A. 1995. Annual Report: Van Arsdale Fisheries Station, 1993-94. California Department of Fish and Game, Inland Fisheries. Administrative Report Number 95-5, 10p.
- Griswold, K. E. 1996. Genetic and meristic relationships of coastal cutthroat trout (*Oncorhynchus clarki clarki*) residing above and below barriers in two coastal basins. M.S. Thesis, Oregon State Univ., Corvallis, OR, 83 p.
- Hannon, J. and M. Healey. 2002. American River Steelhead Redd Surveys, 2001-2002. U. S. Bureau of Reclamation and California Department of Fish and Game. 19 p.
- Hanson, C. H., J. Hagar, S. Englom, and B. Bemis. 1996. Synthesis and analysis of information collected on the fishery resources and habitat conditions of the lower Santa Ynez River: 1993 – 1996.
- Harvey, B. C., J. L. White and R. J. Nakamoto. 2002. Habitat relationships and larval drift of native and nonindigenous fishes in neighboring tributaries of a coastal California river. Trans. Amer. Fish. Soc. 131: 159 – 170.

- Henke, E. 1994. Letters to G. Bryant re: information on steelhead for the Administrative Record for west coast steelhead. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)
- Hulett et al. 1995. Studies of hatchery and wild steelhead in the lower Columbia basin. Washington Department of Fish and Wildlife. Report #RAD 95-3.
- Hunt, W. 1999. Calapooia River St W Spawning Surveys, Winter Steelhead Counts Upper Willamette River, Late-Run Winter Steelhead Run Size Estimates and St W Returns to Minto Trap. ODFW.
- Hunt, L. E., P. E. Lehman, and M. H. Capelli. 1992. Vertebrate resources at Emma Wood State Park and the Ventura River estuary, Ventura County, California: Inventory and management. Calif. Dep. Parks Rec., document dated 6 November 1992, 107 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.)
- IEP (Interagency Ecological Program Steelhead Project Workteam). 1998. Monitoring, assessment, and research on Central Valley steelhead: status of knowledge, review of existing programs, and assessment of needs. Available online at: <http://calfed.ca.gov/programs/cmarp/a7a11.html>
- IDFG (Idaho Department of Fish and Game). 1994. Documents submitted to the ESA Administrative Record for west coast steelhead by E. Leitzinger, 18 October 1994. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.).
- IDFG (Idaho Department of Fish and Game). 2002. Written comments submitted to National Marine Fisheries Service regarding status review.
- James, G. and C. Scheeler. 2001. Walla Walla Subbasin Summary (Draft). Northwest Power Planning Council, Portland, OR.
- Johnson, T. H. and R. Cooper. 1995. Anadromous game fish research and planning, July 1 1993-December 31, 1994. Washington Dept of Fish and Wildlife. Streamnet.org Reference.
- Johnson, O. W., M. H. Ruckelshaus, W. S. Grant, F. W. Waknitz, A. M. Garrett, G. J. Bryant, K. Neely, and J. J. Hard. 1999. Status review of coastal cutthroat trout from Washington, Oregon, and California. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-37, 292 p.
- Jonsson, B. 1985. Life history patterns of freshwater resident and sea-run migrant brown trout in Norway. Trans. Am. Fish. Soc. 114:182-194.

Kaeriyama, M., S. Urawa, and T. Suzuki. 1992. Anadromous sockeye salmon (*Oncorhynchus nerka*) derived from nonanadromous kokanees: Life history in Lake Toro. Sci. Rep. Hokkaido Salmon Hatchery 46:157-174.

Kennedy, T. 2002. Stanislaus River anadromous fish surveys 2000-2001. Report from Fisheries Foundation to A. Hamilton, USFWS, Sacramento, CA.

Kesner, W. D., and R. A. Barnhart. 1972. Characteristics of the fall-run steelhead trout (*Salmo gairdneri gairdneri*) of the Klamath River system with emphasis on the half-pounder. California Fish and Game 58(3):204-220.

Kier & Associates. 2001. Battle Creek salmon and steelhead restoration project. Draft Adaptive Management Plan. Sausalito, CA. 79 p.

Killam, D. 2002. Field notes for Thomes Creek 2002. California Department of Fish and Game, Red Bluff CA.

Kostow, K. 2002. Leaburg and McKenzie abundance. Data delivered via e-mail, September 2002.

Kostow, K. 2003. The biological implications of non-anadromous *Oncorhynchus mykiss* in Columbia basin steelhead ESUs. Report to NOAA Fisheries & ODFW. Draft report to NMFS. Jan. 13, 2003. 90 p.

Mallet, J. 1974. Inventory of salmon and steelhead resources, habitats, use and demands. Job Performance Report. Proj. F-58-R-1. Idaho Dept. of Fish and Game. Boise. Idaho.

Maslin, P. E., M. Lennox, and J. Kindopp. 1998. Intermittent streams as rearing habitat for Sacramento River chinook salmon (*Oncorhynchus tshawytscha*). CSU Chico unpublished report. 51 p.

McClure, M. M., E. E. Holmes, B. L. Sanderson & C. E. Jordan. In press. A large-scale multi-species assessment: Anadromous Salmonids in the Columbia River Basin. 45 p + figures and tables. Ecological Applications.

McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U. S. Dept. Commer. NMFS-NWFSC-42.

McElhany, P., T. Backman, C. Busack, S. Heppell, S. Kolmes, A. Maule, J. Myers, D. Rawding, D. Shively, and C. Steward. 2002. Willamette/Lower Columbia Pacific salmonid viability criteria. Draft report from the Willamette/Lower Columbia Technical Recovery Team. December 2002.

McEwan, D. R. 2001. Central Valley steelhead. In R. L. Brown, editor, *Fish Bulletin 179*, pages 1-43. California Department of Fish and Game, Sacramento, CA.

- McEwan, D. R. 2001. Steelhead rainbow trout. Pages 418-425 in W. S. Leet, C. M. Dewees, C. M Klingbeil, and E. J. Larson, editors. California's living marine resources: a status report. University of California, Agriculture and Natural Resources, Publication SG01-11.
- McEwan, D. R. 2001. Central Valley steelhead. In R. L. Brown, editor, *Fish Bulletin 179*, pages 1-43. California Department of Fish and Game, Sacramento, CA.
- McEwan, D., and T. A. Jackson. 1996. Steelhead restoration and management plan for California. California Dep. Fish Game, 234 p. (Available from California Department of Fish and Game, Inland Fisheries Division, 1416 Ninth Street, Sacramento, CA 95814.)
- Meyer Resources. 1988. Benefits from present and future salmon and steelhead production in California. Report to the California Advisory Committee on Salmon and Steelhead, 78 p. (Available from California Advisory Committee on Salmon and Steelhead Trout, 120 Schoonmaker Point, Foot of Spring Street, Sausalito, CA 94965.)
- Monterey Peninsula Water Management District (MPWMD). 2001. Executive summary, 2000-20001, MPWMD Mitigation Program and Water Allocation Program Environmental Impact Report.
- Moore, M. R. 1980. An assessment of the impacts of the proposed improvements to the Vern Freeman Diversion on anadromous fishes of the Santa Clara River System, Ventura County, California.
- Moore, T. L. 2001. Steelhead Survey Report for Antelope, Deer, Beegum and Mill Creeks, 2001. CDFG Sacramento River Salmon and Steelhead Assessment Program. California Department of Fish and Game. 8 p.
- Mullan, J. W., K. R. Williams, G. Rhodus, T. W. Hillman, and J. D. McIntyre. 1992. Production and habitat of salmonids in mid-Columbia River tributary streams. Monograph I, U.S. Fish and Wildlife Service, Box 549, Leavenworth, WA 98826, 489 p.
- Myers, J. M., C. Busack, D. Rawding, and A. Marshall. 2002. Identifying historical populations of chinook and chum salmon and steelhead within the lower Columbia River and upper Willamette River evolutionary significant units. Draft report to the co-managers from the Willamette/Lower Columbia River Technical Recovery Team (10 May 2002).
- Nehlsen, W., J.E. Williams, and J. A. Lichatowich. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. *Fisheries* 16: 4 – 21.
- Nielsen, J. L., E. A. Heine, C. A. Gan and M. C. Fountain. 2000. Molecular analysis of population genetic structure and recolonization of rainbow trout following the Cantara spill. *California Fish and Game* 88:21-40.

NMFS (National Marine Fisheries Service). 1991. Notice of policy: Policy on applying the definition of species under the Endangered Species Act to Pacific salmon. Federal Register [Docket 910248-1255, 20 November 1991] 56(224):58612-58618.

NMFS (National Marine Fisheries Service). 1993. Endangered and threatened species; Illinois River winter steelhead in Oregon. Federal Register [Docket 930517-3117, 20 May 1993] 58(96): 29390-29392.

NMFS (National Marine Fisheries Service). 1997. Status Review Update for West Coast Steelhead from Washington, Idaho, Oregon, and California. Memorandum from the Biological Review Team to the NMFS Northwest Regional Office. July 7, 1997, 72 p.

NMFS (National Marine Fisheries Service). 1998a. Status review update for deferred and candidate ESUs of west coast steelhead (Lower Columbia River, Upper Willamette River, Oregon Coast, Klamath Mountains Province, Northern California, Central Valley, and Middle Columbia River ESUs). Pre-decisional ESA document, National Marine Fisheries Service.

NMFS (National Marine Fisheries Service). 1998b. Status review update for deferred ESUs of west coast steelhead: hatchery populations (Lower Columbia River, Klamath Mountains Province, Northern California, and Central Valley). Predecisional ESA document, National Marine Fisheries Service.

NMFS (National Marine Fisheries Service). 1999. Updated Review of the Status of the Upper Willamette River and Middle Columbia River ESUs of Steelhead. Memorandum for W. Stelle and W. Hogarth from M. Schiewe. January 12, 1999, 49 p.

NMFS (National Marine Fisheries Service). 2002. Memorandum for Frank L. Cassidy, Jr. (Northwest Power Planning Council) from Bob Lohn (NMFS), April 2002. (Available at <http://www.nwr.noaa.gov/occd/InterimTargets.pdf>)

Nobriga, M. 1995. Cosumnes River study. California Department of Fish and Game, Rancho Cordova, CA. 10 p.

Nobriga, M. and P. Cadrett. 2001. Differences among hatchery and wild steelhead: evidence from Delta fish monitoring programs. IEP Newsletter 14: 30-38.

Nordeng, H. 1983. Solution to the "char problem" based on Arctic char (*Salvelinus alpinus*) in Norway. Can. J. Fish. Aquat. Sci. 40:1372-1387.

Nowak, M.C. 2001. Draft Grande Ronde Subbasin Summary. Prepared for the Northwest Power Planning Council. 385 pages.

ODFW (Oregon Department of Fish and Wildlife). 1990. Santiam and Calapooia Rivers: Willamette River subbasin : salmon and steelhead production plan. Oregon Department of Fish and Wildlife. Northwest Power Planning Council.

ODFW (Oregon Department of Fish and Wildlife). 1991. Grand Ronde River subbasin salmon and steelhead plan. Prepared for Northwest Power Planning Council. 129 pp.

ODFW (Oregon Department of Fish and Wildlife). 1999. Personal communications for reconstructed run year estimates from punch cards for steelhead, 1956-1970. Unpublished.

ONRC (Oregon Natural Resources Council), Siskiyou Regional Education Project, Federation of Fly Fishers, Kalmiopsis Audubon Society, Siskiyou Audubon Society, Klamath/Siskiyou Coalition, Headwaters, The Wilderness Society, North Coast Environmental Center, Oregon Chapter of The Sierra Club, and The National Wildlife Federation. 1992. Petition for a rule to list the Illinois River winter steelhead as threatened or endangered under the Endangered Species Act and to designate critical habitat. Unpubl. manuscr., 16 p. (Document submitted to USDOC NOAA NMFS Northwest Region, Seattle, Washington, May 1992).

Puckett, L. K. 1969. Fisheries surveys on Thomes and Stony Creeks, Glenn and Tehama Counties, with special emphasis on their potentials for King Salmon spawning. California Department of Fish and Game, Water Projects Branch Administrative Report No. 69-3. 24 p.

Rawding, D. 2002a. Lower Columbia River summer-run steelhead. Excel Workbook sent from Dan Rawding (WDFW) to Paul McElhany via e-mail to Paul McElhany and Sarah Sydor, NWFSC.

Rawding, D. 2001b. Simsam (Steelhead). Unpublished data and documentation sent from Dan Rawding (WDFW) to Paul McElhany on 5/16/2001 as Excel file and Word document, via e-mail.

Reavis, B. 1991. Status of California steelhead stocks. In Pacific States Marine Fisheries Commission and Association of Northwest Steelheaders (organizers), International Symposium on Steelhead Trout Management, January 3-5, 1991, Portland, OR, p. 57 – 63.

Reese, C. D. and B. C. Harvey. 2002. Temperature-dependent interactions between juvenile steelhead and Sacramento pikeminnow in laboratory streams. Trans. Am. Fish. Soc. 131: 599 – 606.

Reynolds, F. L., T. J. Mills, R. Benthin and A. Low. 1993. Restoring Central Valley streams: a plan for action. California Department of Fish and Game, Sacramento, CA, 184 p.

Robertson, S. R. 1985. Clavey River wild trout habitat management plan. Stanislaus National Forest, Sonora, CA, 14 p. (from CV steelhead; not in master list)

- Rode, M., and Weidlein, W. D. 1986. California wild trout management program, Fall River management plan. California Department of Fish and Game, Inland Fisheries Admin. Rpt. 86-2. 55 p. (from CV steelhead; not in master list)
- Roelofs, T. D. 1983. Current status of California summer steelhead (*Salmo gairdneri*) stocks and habitat, and recommendations for their management. Submitted to USDA Forest Service, Region 5, 77 p. (Available from Environmental and Technical Services Division, Natl. Mar. Fish. Serv., 525 N.E. Oregon Street, Suite 500, Portland, OR 97232.).
- Ruiz-Campos, G. and E. P. Pister. 1995. Distribution, habitat, and current status of the San Pedro Martir rainbow trout, *Oncorhynchus mykiss nelsoni* (Evermann). Bulletin of the Southern California Academy of Sciences, 94(2): 131 – 148.
- Schill, D. J. and R. L. Scarpella. 1997. Barbed hook restrictions in catch-and-release trout fisheries: a social issue. N. Am. J. Fish. Man. 17: 873 – 881.
- Servheen, G. Draft Salmon Subbasin Summary. Prepared for the Northwest Power Planning Council. 481 p. + app.
- Shapovalov, L. 1944. Preliminary report on the fisheries of the Santa Ynez River System, Santa Barbara County, California. CDFG Report, 22 pp.
- Shapovalov, L. and A. C. Taft. 1954. The life histories of the steelhead rainbow trout (*Salmo gairdneri gairdneri*) and silver salmon (*Oncorhynchus kisutch*) with special reference to Waddell Creek, California, and recommendations regarding their management. Calif. Dep. Fish Game Fish Bull. 98, 375 pp.
- Sharp, B. 2001. Klickitat Subbasin Summary. Northwest Power Planning Council, Portland, OR.
- Shea, K., and M. Mangel. 2001. Detection of population trends in threatened coho salmon (*Oncorhynchus kisutch*). Can. J. Fish. Aquat. Sci. 58: 375-385.
- Smith, J. J. 1994. Abundance of coho and steelhead in Redwood Creek in 1994. Department of Biological Sciences, San Jose State University. San Jose, CA.
- Smith, J. J. 1992. Distribution and abundance of juvenile coho and steelhead in Waddell, Scott and Gazos Creeks in 1992. Department of Biological Sciences, San Jose State University. San Jose, California.
- Smith, J. J. 1994. Distribution and abundance of juvenile coho and steelhead in Scott and Gazos Creeks in 1993. Department of Biological Sciences, San Jose State University. San Jose, CA.

- Smith, J. J. 1994. Distribution and abundance of juvenile coho and steelhead in Scott and Waddell Creeks in 1988 and 1994: Implications for status of southern coho. Department of Biological Sciences, San Jose State University. San Jose, California.
- Smith, J. J. 1995. Distribution and abundance of juvenile coho and steelhead in Waddell, Scott and Gazos Creeks in 1995. Department of Biological Sciences, San Jose State University. San Jose, California.
- Smith, J. J. 1996. Distribution and abundance of coho and steelhead in Redwood Creek in November 1996. Department of Biological Sciences, San Jose State University. San Jose, California.
- Smith, J. J. 1996. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott Creeks in 1995. Department of Biological Sciences, San Jose State University. San Jose, California.
- Smith, J. J. 1996. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott Creeks in 1996. Department of Biological Sciences, San Jose State University. San Jose, California.
- Smith, J. J. 1997. Distribution and abundance of coho and steelhead in Redwood Creek in fall 1997. Department of Biological Sciences, San Jose State University. San Jose, California.
- Smith, J. J. 1998. Distribution and abundance of coho and steelhead in Redwood Creek in fall 1998. San Jose, California.
- Smith, J. J. 1998. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott Creeks in 1997 and the implications for status of southern coho. Department of Biological Sciences, San Jose State University. San Jose, California.
- Smith, J. J. 1998. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott Creeks in 1998. Department of Biological Sciences, San Jose State University. San Jose, California.
- Smith, J. J. 1999. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott Creeks in 1999. Department of Biological Sciences, San Jose State University. San Jose, California.
- Smith, J. J. 2000. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott Creeks in 2000. Department of Biological Sciences, San Jose State University. San Jose, California.
- Smith, J. J. 2000. Distribution and abundance of juvenile coho and steelhead in Redwood Creek in fall 2000. San Jose, California.

- Smith, J. J. 2001. Distribution and abundance of juvenile coho and steelhead in Gazos, Waddell and Scott Creeks in 2001. Department of Biological Sciences, San Jose State University. San Jose, California.
- Smith, J. J. 2001. Distribution and abundance of juvenile coho and steelhead in Redwood Creek in fall 2001. Department of Biological Sciences, San Jose State University. San Jose, California.
- Smith, J. J. 2002. Distribution and abundance of juvenile coho and steelhead in Redwood Creek in fall 2002. Department of Biological Sciences, San Jose State University. San Jose, California.
- Snider, B., and R. G. Titus. 1998. Evaluation of juvenile anadromous salmonid emigration in the Sacramento River near Knights Landing; November 1995 - July 1996. California Department of Fish and Game, Stream Evaluation Program Technical report 98-5.
- Snider, B., and R. G. Titus. 2000a. Timing, composition and abundance of juvenile anadromous salmonid emigration in the Sacramento River near Knights Landing; October 1996 - September 1997. California Department of Fish and Game, Native Anadromous Fish and Watershed Branch, Stream Evaluation Program Technical report 00-4.
- Snider, B., and R. G. Titus. 2000b. Timing, composition and abundance of juvenile anadromous salmonid emigration in the Sacramento River near Knights Landing October 1997- September 1998. California Department of Fish and Game, Habitat Conservation Division, Native Anadromous Fish and Watershed Branch, Stream Evaluation Program Technical Report 00-5.
- Snider, B., and R. G. Titus. 2000c. Timing, composition and abundance of juvenile anadromous salmonid emigration in the Sacramento River near Knights Landing; October 1998 - September 1999. California Department of Fish and Game, Native Anadromous Fish and Watershed Branch, Stream Evaluation Program Technical report 00-6.
- Snider, W. M. 1983. Reconnaissance of the steelhead resource of the Carmel River drainage, Monterey County. Calif. Dep. Fish Game, Environmental Services Branch Admin. Rep. 83-3., 41 p. (Available from California Department of Fish and Game, Inland Fisheries Division, 1416 Ninth Street, Sacramento, CA 95814.)
- Snyder, J. O. 1925. The half-pounder of Eel River, a steelhead trout. Calif. Fish Game 11(2): 49-55.
- Stephens, S. J., Christenson, D. P., Lechner, M., and Werner, H. 1995. Upper Kern Basin fishery management plan. California Department of Fish and Game, Sacramento, CA, 86 p.

- Stoecker, M.W. and CCP (Conception Coast Project). 2002. Steelhead assessment and recovery opportunities in Southern Santa Barbara County, California. Conception Coast Project, Santa Barbara.
- Titus, R. G., D. C. Erman, and W. M. Snider. MS. History and status of steelhead in California coastal drainages south of San Francisco Bay.
- Titus, R. G. and C. D. Vanicek. 1988. Comparative hooking mortality of lure-caught Lahontan cutthroat trout at Heenan Lake, California. Calif. Fish Game 74: 218 – 225.
- USFWS (U.S. Fish and Wildlife Service). 2000. Anadromous fish restoration actions in the Butte Creek Watershed. Programmatic Environmental Assessment. Sacramento, CA.
- Waples, R. S. 1998. Willamette Steelhead. Memorandum to Mike Delarm and Garth Griffin, NMFS Regional Office, Portland, 2 July 1998. 2 p.
- WDF (Washington Department of Fisheries), Washington Department of Wildlife (WDW), and Western Washington Treaty Indian Tribes (WWIT). 1992. 1992 Washington State salmon and steelhead stock inventory (SASSI). Wash. Dep. Fish Wildl., Olympia, 212 p. + 5 regional volumes. (Available from Washington Department of Fish and Wildlife, 600 Capitol Way N., Olympia, WA 98501-1091.)
- WDFW ((Washington Department of Fisheries and Wildlife)). 1997. "Preliminary stock status update for steelhead in the Lower Columbia River, Washington (WDFW Kalama Research)." Data via Michelle McClure; references from Eli Holmes.
- Withler, R. E. 1988. Genetic consequences of fertilizing chinook salmon (*Oncorhynchus tshawytscha*) eggs with pooled milt. Aquaculture 68: 15-25.
- Workman, M. L. 2001. Lower Mokelumne River upstream fish migration monitoring conducted at Woodbridge Irrigation District Dam, August 2000 through April 2001. East Bay Municipal Utility District, Lodi, CA. 21 p.
- Yoshiyama, R. M., F. W. Fisher, and P. B. Moyle. 1998. Historical abundance and decline of chinook salmon in the Central Valley region of California. N. Am. J. Fish. Man. 18:487-521.
- Zimmerman, C. E. and G. H. Reeves. 2000. Population structure of sympatric anadromous and nonanadromous *Oncorhynchus mykiss*: evidence from spawning surveys and otolith microchemistry. Can. J. Fish. Aquat. Sci. 57:2152-2162.

## B.5 APPENDICES

Appendix B.5.1. Distribution of *O. mykiss* trout by category in the Columbia Basin steelhead ESUs. Only major barriers are noted; numerous small barriers, both natural and artificial, also exist. Many other natural barriers are present but have *O. clarkii* trout, rather than *O. mykiss* trout, above them. *O. mykiss* trout distribution in areas of sympatry with steelhead may be restricted in some areas if native *O. clarkii* trout are also in the basin. The generalized listing of basins and subbasins does not imply that these constitute single trout populations or that trout distribution is continuous throughout the areas listed. Detailed trout distribution is usually unknown and actual demographically independent trout populations have not been described. All current trout distributions are decreased from historical distributions. In particular many mainstem and lower basin tributary are no longer used but probably were historically. Many current trout populations are only in upper basins and are highly fragmented (from Kostow 2003).

ESU	Category 1 Trout Populations (Sympatric)	Category 2 Trout Populations (Major Natural Barriers)	Category 3 Trout Populations (Major Artificial Barriers)
Willamette River	Pudding/Molalla Lower Santiam Calapooia Tualatin (Gales Cr.)	All populations upstream of Calapooia  McKenzie M. Fork Willamette	N. Fork Santiam (Big Cliff/Detroit dams)  S. Fork Santiam (Green Peter Dam)
Lower Columbia River	Historic use of lower basins by trout may have been greater Wind Clackamas: Callowash Other areas (?)	Clackamas: Roaring R. North Fork South Fork Memaloose (?)  Hood: West Fork Middle Fork  Sandy (?) Upper Cowlitz Upper Kalama Upper Lewis Upper Washougal	Cowlitz (Mayfield Dam)  Lewis (Merwin Dam)  Sandy (Bull Run dams)  Sandy: Little Sandy Salmon (?)  Some of the Columbia Gorge small tributaries

Appendix B.5.1 (continued)

<b>ESU</b>	<b>Category 1 Trout Populations (Sympatric)</b>	<b>Category 2 Trout Populations (Major Natural Barriers)</b>	<b>Category 3 Trout Populations (Major Artificial Barriers)</b>
Middle Columbia River	Historically all areas where steelhead are/were present. Trout distributions currently more restricted.	All natural barriers upstream of Klickitat and Deschutes Basins:  Deschutes:  Fifteenmile Eightmile Deschutes Klickitat  Umatilla: Upper Umatilla  John Day: Upper tributaries  Walla Walla Upper tributaries  Yakima: Upper Yakima Naches  Some other small tributaries	Trout distributions currently more restricted than historically  Little White Salmon (Conduit Dam)  Deschutes (Pelton/Round Butte dams) Metolius Squaw Cr. Crooked River  Umatilla (Irrigation dams) Willow Cr. Butter Cr. McKay Cr.

Appendix B.5.1 (continued)

ESU	Category 1 Trout Populations (Sympatric)	Category 2 Trout Populations (Major Natural Barriers)	Category 3 Trout Populations (Major Artificial Barriers)
Snake River	Potentially all areas that are/were used by steelhead.	<p>Palouse River</p> <p>Malad River</p> <p>Several Hells Canyon tributaries</p> <p>Upper Malheur Basin “recent” disconnect from lower Malheur Lakes Basin</p> <p>found in about 43% of streams</p> <p>Clearwater</p> <p>Selway</p> <p>Other areas?</p>	<p>Trout distributions currently more restricted than historically</p> <p>North Fork Clearwater (Dworshak Dam)</p> <p>Mainstem Snake (Hells Canyon Dam)</p> <p>Powder</p> <p>Burrit</p> <p>Malheur</p> <p>Owhyee</p> <p>Weiser</p> <p>Payette</p> <p>Boise</p> <p>Burneau</p> <p>Salmon Falls Cr.</p> <p>Several small tributaries</p>
Upper Columbia River	Potentially all areas that are/were used by steelhead	<p>Upper Entiat</p> <p>Upper Kootenay</p> <p>Okanogan:</p> <p>Enlow Falls?</p> <p>Wenatchee</p> <p>Lower Entiat</p> <p>Methow</p> <p>Okanogan</p>	<p>Trout distributions currently more restricted than historically</p> <p>Okanogan Basin:</p> <p>Conconully Dam/Enlow Dam?</p> <p>Chief Joseph Dam</p> <p>Lower Spokane to Post Falls</p> <p>Sanpoil</p> <p>Several small tributaries</p> <p>Lower Pend Oreille to Z-Canyon</p> <p>Columbia headwaters in Canada</p>

Appendix B.5.2. Distribution, abundance, and stocking of *Oncorhynchus mykiss* above major recent barriers (Case 3 situations) within 5 steelhead ESUs in California, listed by ESU and watershed. A major barrier blocks or restricts access to  $\geq 100$  square miles of a watershed. Names of keystone (lowermost complete) barriers are shown in bold, partial or seasonal barriers shown in italics. SH=steelhead, RT=rainbow trout (usually means resident),?=unknown. Blanks indicate no data. See text for details.

#### ESU / Basin / Subbasin

..... Stream Length .....

*O. mykiss* above barrier

ESU / Basin / Subbasin		Above Barrier					Density (no./km)	most stocked	most recent	hatchery	stocking notes	source
		Year Built	Total (km)	Barrier (km)	(%)	present						
<b>Northern California</b>												
Mad River	<b>Robert W Matthews</b>	1962	1,188	282	24%	yes	low; gets warm in summer	yes	ongoing	various	18,000 / year	4
Eel River	<i>Van Arsdale</i>	1907	1,106	13%	SH, RT							
	<b>Scott</b>	1921	963	11%	yes							17,5
Sfk Eel River	<i>Benzow</i>	1932	949	11%	SH							
	ESU Total		15,496	1,245	8%							
<b>Central California Coast</b>												
Russian River			3,129									
Russian River	<i>Russian Rv No I</i>	1963	2,878	92%								
	<i>Healdsburg Rec</i>	1953	2,591	83%								
Dry Creek	<b>Warm Springs</b>	1982	271	9%	yes	all trib		yes	private,	~1984-87, Russian River		6
									Warm Springs			
E Fk Russian River	<b>Coyote Valley</b>	1959	269	9%	yes			yes				
Lagunitas Creek			202									

## ESU / Basin / Subbasin

## ---- Stream Length ----

		<i>O. mykiss</i> above barrier			
Dam Name	Year Built	Total (km)	Above Barrier (%)	Above Barrier (%)	source
			present distribution	abundance	
Seeger	1961	100	50%	yes	6 hdwtrs of Halleck Cr, prob. in western portion of Nicasio Cr.
Peters	1954	61	30%	yes	yes ongoing Silverado Fisheries Base
Alameda Creek		1,658			
Alameda Creek <b>Rubber Dam 1</b>		1,578	95%	yes	yes
Rubber Dam 3	1990	1,578	95%		
Calaveras Creek Calaveras	1925	283	17%		
Arroyo Valle Del Valle	1968	413	25%		yes
Coyote Creek		757			
Coyote <b>Standish</b>	1994	747	99%		
Coyote Creek Coyote Percol	1934	532	70%		
Coyote River Leroy Anderson	1950	487	64%		
Coyote Creek Coyote	1936	278	37%		
ESU Total		11,447	3,026	26%	
<b>South Central California Coast</b>					
Salinas River		9,966			
San Antonio Rv San Antonio	1965	1,102	11%	yes in reservoir, unknown if in stream	yes ongoing Silverado Fisheries Base
Nacimiento Rv Nacimiento	1957	761	8%	yes	330-390 yes ongoing Silverado Fisheries Base
Salinas River Salinas	1942	293	3%	yes	yes ongoing Silverado released at Lake Margarita marina
Carmel River	656				1,7
San Clemente	1921	337	51%	SH	1,7

**ESU / Basin / Subbasin**
**---- Stream Length ----**
*O. mykiss above barrier*

	Dam Name	Year Built	Total (km)	Above Barrier (km)	Above Barrier (%)	present distribution	abundance	Density (no./km)	stocked	most recent	source	hatchery	stocking notes	source
<i>Los Padres</i>		1949	128	20%	SH, RT			no			trap and truck of steelhead around Los Padres Dam for 20 yrs			1,7
<i>Big Sur Coastal</i>			711											
<i>Estero Bay Coastal</i>	<b>Old Creek</b>	<b>Whale Rock</b>	1960	44	42	95%	yes		yes		Whale Rock	55,000 total from 1992-2002, broodfish taken from Whale Rock Reservoir		29
<i>Arroyo Grande Lopex Cr</i>		1969	282	143	51%	yes			yes	ongoing	Silverado Fisheries Base			1
	ESU Total		19,213	2,469	13%									
<b>Southern California</b>														
<i>Santa Maria River</i>			5,775							yes	10-15 yrs ago			2
<i>Cuyama River Twitchell</i>		1958		4,088	71%	yes	all trib				(~1987-1992)			
<i>Santa Ynez River</i>			2,619											
<i>Santa Ynez River</i>	<b>Bradbury</b>	1953		1,517	58%	yes	all trib			yes	ongoing	Fillmore into Lake Cachuma		2, 9, 10
<i>Santa Ynez Rv Gibraltar</i>		1920		721	28%	yes	all trib			yes	ongoing	Fillmore not open to fishing?		2, 10
<i>Juncal</i>		1930		49	2%	yes	all trib	lots of RT, up to 26"		?	no stocking in last 30 yrs			28
<i>Ventura River</i>			644											

## ESU / Basin / Subbasin

---- Stream Length ----

*O. mykiss above barrier*

		Year Built	Total (km)	Barrier (km) (%)	present	distribution	abundance	Density (no./km)	most stocked	recent	source
Dam Name	Dam Name									hatchery	stocking notes
Coyote Creek	Castitas	1959	131	20%	yes	where water present, note seasonal streams		yes	ongoing	Fillmore	32,000 pounds in 2002
Matilija Creek	<b>Robles Diversion</b>	1958	224	35%	yes						2
Matilija		1949	157	24%	yes					5-6 yrs ago (~1996- 97)	2, 11
Santa Clara River		3,851									2, 18
Santa Clara River	<i>Vern Freeman Diversion</i>	1991	3,830	99%	yes						
Piru Creek	<b>Santa Felicia</b>	1955	1,192	31%	yes	all trib	2371-2940; 107-143 (>8"); 0 (>12")	yes	ongoing	Fillmore	Hot Creek strain, into Lake Piru and Frenchman's Flat
Pyramid		1973	825	21%	yes	all trib					2
Castaic Creek	<b>Castaic Ridge</b>	1973	378	10%	yes	reservoir and where water present, note seasonal streams		yes	ongoing	Fillmore	into Castaic Lake and Castaic Lagoon (below dam)
Malibu Creek		269									
subtotal		15,490	7,463	48%							
Los Angeles River		1,220									
Los Angeles River	<b>Sepulveda<sup>A</sup></b>	1941	215	18%	no						2
Tujunga Wash	<b>Hansen</b>	1940	408	33%	yes	~5 miles or where water present	few fish		yes	ongoing	Fillmore
San Gabriel River		1,270									

## ESU / Basin / Subbasin

## ---- Stream Length ----

*O. mykiss above barrier*

ESU / Basin / Subbasin	Dam Name	Year Built	Total (km)	Barrier (km)	present (%)	distribution	abundance	Density (no./km)	stocked	most recent	source	hatchery	stocking notes	source
San Gabriel River	Whittier Narrows <sup>A</sup>	1957	1,192	94%	yes	reservoir, but probably not far upstream		yes	ongoing	Fillmore				2
Santa Fe	1949	692	54%	yes	reservoir, but probably not far upstream			yes	ongoing	Fillmore				2
Morris	1935	626	49%	yes	reservoir			no, washdown from above						2
San Gabriel No 1	No 1938	577	45%	yes	all trib where there is water, EF usu perennial		1550-2706; 129-198 (>8"); 0 (>12")	yes	ongoing	Fillmore	in WF below Cogswell, NF, and EF of San Gabriel R			2, 21
Cogswell	1935	121	10%	yes										2
Santa Ana River	4,620													
Santa Ana River Prado <sup>A</sup>	1941	3,158	68%	yes			96-732; 14-15 (>8"); 0 (>12")							20, 21
Bear Creek														
Upper Santa Ana River							yes			29-43; 0-14 (>8"); 0 (>12")				21
San Antonio Creek	San Antonio	1956	73	2%										
Santa Ana River Seven Oaks	undrcn st		594	13%										
Tr Cajalco Cr	Mathews	1938	95	2%										
Santa Margarita River		1,604												
Temecula Creek Vail	1949	655	41%											
San Luis Rey River Henshaw							yes	private stocking						2
San Dieguito River Lake Hodges	1918	693	618	89%	no		yes	ongoing	Mojave	into WF of San Luis Rey				2
San Diego River El Capitan	1934	1,013	558	55%	yes	in reservoir	few fish	no	no	bass and catfish in L. Hodges				2

**ESU / Basin / Subbasin**

---- Stream Length ----

*O. mykiss above barrier*

Dam Name	Year Built	Above Barrier		Density (no./km)	most stocked	recent	source
		Total (km)	(%) present				
Sweetwater River	Sweetwater Main	1888	440	367	83%	yes	2
Otay River	<b>Savage</b>	1919	410	333	81%		
Tijuana River <sup>C</sup>			734				
Cottonwood Cr	<b>Barrett</b>	1922		506			
Morena		1912		210			
ESU Total			31,964	15,414	48%		
<b>Central Valley</b>							
Sacramento River		52,206					
	<i>Red Bluff Diversion</i>	1964	14,261	27%	SH		
	<i>Anderson Cottonwood</i>	1917	9,224	18%	SH		
	<b>Keswick</b>	1950	9,189	18%	yes		
	Shasta	1945	9,106	17%	yes		
Upper Sacramento		568					
	Shasta	1945		yes			
Mc Cloud River	Box Canyon	1969	127	22%	yes		
	Shasta	1945	949	yes			
					2361 (>5")		4

## ESU / Basin / Subbasin

## ---- Stream Length ----

*O. mykiss above barrier*

ESU / Basin / Subbasin	Dam Name	Year Built	Total (km)	Above Barrier (km)	Above Barrier (%)	present distribution	abundance	Density (no./km)	stocked	most recent	source hatchery	stocking notes	source
McCloud	Shasta	1945	6,979			yes		1864 (Squaw Valley Cr)	yes	ongoing below	15,000 yr into McCloud reservoir		4
Fall River	Pit No 1 Diversn	1922				yes	1021-2541 (>6")						22
	Pit No 1 Forebay	1947				yes							
Hat Creek	Burney	Hat Cr No 2 Div	1942			yes	159-2539 (>8"); 32-1335 (>12")						19
Clear Creek	Whiskeytown	1963	462	377	82%	yes	Whiskey Cr and Clear Cr	1553-3107	yes	ongoing private hatchery			
Stony Creek	Stony Cr Gravel	1906		2,707									
	<b>Black Butte</b>	1963		2,427	90%	yes	migrate through Stony and Grindstone Crs, too warm in summer						13
Little Stony Creek	Stony Gorge	1928				yes	all trib			yes	ongoing		13
	East Park	1910				yes	Trout Cr and Stony Cr seasonally			yes			13
Cache Creek				3,362									

## ESU / Basin / Subbasin

---- Stream Length ----

*O. mykiss above barrier*

Dam Name	Year Built	Above Barrier		Density (no./km)	most stocked	recent hatchery	stocking notes	source
		Total (km)	(%) present					
Cache Creek Cache Cr Settling Bn		3,362	100%					
Putah Creek	1,200							
Putah Creek Putah Div	1957	1,087	91%					
Monticello	1957	1,010	84%					
Feather River	9,094							
Feather River Thermalito Div	1967							
Feather R Hatchery	1964							
Oroville	1968	7,702	85%					
Nfk Feather Rv Poe	1959							
Lake Almanor	1927	yes						
Bucks Creek Bucks Storage	1928	yes						
MRK Feather R		yes						
Nelson Creek		yes						
Yuba River	3,510							
Yuba River Englebright	1941	2,923	83%					
Bear River	1,180							
Camp Far West	1963	719	61%					
American River	4,480							
American River Nimbus	1955	4,351	97%					
Rubicon River					yes			
Cosumnes River Granles <sup>B</sup>	1921	2,426	1,322	54%				
Mokelumne River	1,877							
Mokelumne Woodbridge River	1910	1,858	99%					
Diversions								

NF below L  
Almanor  
rotened at least  
3x

NF below L  
last 15 yr

15-30,000/yr during  
last 15 yr

above wild trout  
section of MF

ongoing Eagle  
Lake strain

ongoing

ongoing

yes

*O. mykiss* above barrier  
ESU / Basin / Subbasin  
--- Stream Length ---

..... Stream Length .....

- A extensive portions of river below dam are channelized or concrete apron
- B Granlees Dam is not considered a keystone barrier for steelhead, impassable natural falls below dam
- C portion in California
- 1 pers. comm., Jennifer Nelson, CDFG
  - 2 pers. comm., Dwayne Maxwell, CDFG
  - 3 pers. comm., Dennis Maria, CDFG
  - 4 pers. comm., CDFG Region 1 biologists; Mike Dean, Mike Berry, Randy Bentlin, Bob McAllister, Bill Jong, Phil Barrington
  - 5 pers. comm., Scott Downie, CDFG
  - 6 pers. comm., Bill Cox, CDFG
  - 7 pers. comm., Mike Hill, CDFG
  - 8 pers. comm., Joel Casagrande, Watershed Institute, CSUMB
  - 9 pers. comm., Mauricio Cardenas, CDFG
  - 10 pers. comm., Scott Engblom, Cachuma Operation and Maintenance Board
  - 11 pers. comm., Rick Rogers, NMFS
  - 12 pers. comm., Ken Kundargi, CDFG
  - 13 pers. comm., Emil Ekman, USFS
  - 14 CDFG 1979.
  - 15 CDFG 1986.
  - 16 CDFG 2000.
  - 17 Jones 2001
  - 18 McEwan and Jackson 1996
  - 19 Deinstadt and Berry 1999
  - 20 Deinstadt et al. 1993
  - 21 Deinstadt et al. 1990
  - 22 Rode and Weidlein 1986
  - 23 Robertson 1985
  - 24 Yoshiyama et al. 2001
  - 25 Titus et al. 2001
  - 26 Deinstadt et al. 1995
  - 27 Stephens et al. 1995
  - 28 pers. comm. to M. Capelli, Jim Adams, CDFG
  - 29 pers. comm., John Bell, Whale Rock Hatchery

## **Overview**

The above table summarizes available information on the distribution, abundance, and stocking of *O. mykiss* above recent barriers (Case 3) within the five listed steelhead ESUs in California. Populations above longstanding natural barriers (Case 2) and below barriers (Case 1) are not listed. Historically, coastal *O. mykiss* were broadly distributed in coastal watersheds and within the Central Valley (Behnke 1992, McEwan and Jackson 1996). Hatchery produced *O. mykiss* have been stocked for over 100 years (Behnke 1992) into streams and lakes throughout California by numerous state and federal agencies, private groups, and individuals. Given their broad historical range and widespread stocking over the last century, *O. mykiss* probably occur above all major recent barriers in California. However little specific information is available on their distribution and abundance above these barriers, and stocking records are incomplete and not centralized. Because of these limitations, this table is necessarily incomplete and is intended to provide information at the level of the ESU.

## **Methods and scope**

Data were obtained from several sources. Barrier data were derived primarily from the California Department of Water Resources (DWR, 1993) and the National Inventory of Dams (NID) compiled by the U.S. Army Corps of Engineers. Data for a few dams were missing from these databases and were obtained from other sources. These databases list over 1400 unique dams on rivers and streams in California. Of these, fewer than 200 were classified as major barriers. A major barrier was arbitrarily defined as one that blocks or restricts access to  $\geq 100$  mi<sup>2</sup> of a watershed. Keystone barriers are the lowermost complete barrier to upstream migration in a watershed. For brevity, major barriers upstream of keystone barriers are not shown for the Central Valley ESU if there is no associated data on *O. mykiss*. A few minor barriers were included if information was available.

Stream lengths were derived from the National Hydrography Dataset (NHD) produced by the U.S. Geological Survey and U.S. Environmental Protection Agency. Total stream length for a watershed (or ESU) is the sum for all streams within the watershed (or ESU), not just streams or watersheds that are listed. Above barrier totals are the sum for all streams above the barrier (watershed) or above listed keystone barriers (ESU). The above barrier totals include sections of streams that may be above longstanding natural barriers and exclude streams above smaller keystone barriers that are not listed in the table.

Data on the distribution, abundance, and stocking of *O. mykiss* were obtained from the literature and from interviews with regional fish biologists with the California Department of Fish and Game, NMFS, and other agencies and academic institutions. Data on *O. mykiss* refer to fish that occur above the associated barrier but below the next upstream barrier, if it exists. Fish densities were converted from number per mile, but were not rounded to reflect true precision of estimate.

Appendix B.5.3. SSHAG (2003) categorizations of hatchery populations of 9 of the steelhead ESUs reviewed. See “Artificial Propagation” in General Introduction for explanation of the categories.

<b>ESU</b>	<b>Stock</b>	<b>Run</b>	<b>Basin</b>	<b>SSHAG Category</b>
Snake River	Wallowa	summer	Wallowa	3c
	Cottonwood	summer	Grande Ronde	3c
	Little Sheep Creek	summer	Imnaha	2a
	Oxbow	summer	Snake	3c
	Sawtooth	summer	Salmon	3c
	Pahsimeroi	summer	Salmon	3c
	Dworshak	summer	Clearwater	2a
	Lyons Ferry	summer	Snake	3c or 4
	Tucannon (Lyons Ferry)	summer	Tucannon	3c or 4
Upper Columbia River	Tucannon (new)	summer	Tucannon	1a
	Curl Lake	summer	Snake	3 or 4
	Wells	summer	Upper Columbia	2b
Middle Columbia River	Wenatchee	summer	Wenatchee	1b
	Deschutes (# 66)	summer	Deschutes	2a or 2c
Lower Columbia River	Umatilla (# 91)	summer	Umatilla	1a
	Dayton Pond	summer	Touchet	4
	Dayton Pond (new)	summer	Touchet	1a
	Skamania	summer	Washougal	4
Upper Willamette River	Sandy (ODFW 11)	winter	Sandy	1a
	Clackamas (#122)	winter	Clackamas	1a
	Hood (ODFW #50)	winter	Hood	1a
	Hood (ODFW #50)	summer	Hood	1a
	Big Creek/Eagle Creek	winter	Clackamas	4
	Chambers Creek	winter	various	4
	Cowlitz	late-winter	Cowlitz	2a
	Kalama	winter	Kalama	1a
	Kalama	summer	Kalama	1a
	Skamania (# 24)	summer	Santiam	4
Northern CA	Mad River	winter	Mad	3c
	Yager Creek	winter	Yager	1a
	N. Fork Gualala	winter	Gualala	1a
Central CA Coast	Don Clausen	winter	Russian	2a
	Monterey Bay	winter	Scott Creek	1a
South-Central CA Coast	Whale Rock	winter	Old Creek	1a or 2a
CA Central Valley	Coleman NFH	winter	Sacramento	2a
	Feather River	winter	Feather	2a
	Nimbus Hatchery	winter	American	4
	Mokelumne Hatchery	winter	Mokelumne	4

**Appendix B.5.4. Steelhead Time Series References**

<b><u>Snake River Steelhead ESU</u></b>	
Population	Snake River Steelhead (total)
Years of Data, Length of Series	1980 - 2001, 22 years
Abundance Type	Total Live Count
Abundance References	12 ESU's data file, Eli Holmes, NWFSC
Abundance Notes	
Hatchery Reference	12 ESU's data file, Eli Holmes, NWFSC
Hatchery Notes	
Harvest Notes	US v. Oregon T.A.C. Spreadsheets from Henry Yuen
Age Reference	12 ESU's data file, Eli Holmes, NWFSC
Age Notes	average
Population	Inmnaha R (Zumwalt/Camp Creek)
Years of Data, Length of Series	1974 - 2000, 27 years
Abundance Type	Redds per Mile
Abundance References	updated spreadsheets from M. Chilcote, ODFW -2002
Abundance Notes	
Hatchery Reference	Chilcote 2001
Hatchery Notes	
Harvest Reference	Chilcote 2001
Harvest Notes	
Age Reference	Chilcote 2001
Age Notes	average
Population	Camp Creek (Inmnaha)
Years of Data, Length of Series	1974 - 2002, 29 years
Abundance Type	Total Live Count
Abundance References	Chilcote 2002
Abundance Notes	
Hatchery Reference	Chilcote 2002
Hatchery Notes	

Harvest Reference	Chilcote 2002
Harvest Notes	
Age Reference	Used Grande Ronde River aggregate
<u>Age Notes</u>	average
Population	Grande Ronde River, Upper
Years of Data, Length of Series	1967 - 2000, 34 years
Abundance Type	Redds per Mile
Abundance References	Chilcote 2001
Abundance Notes	
Hatchery Reference	Chilcote 2001
Hatchery Notes	
Harvest Reference	Chilcote 2001
Harvest Notes	
Age Reference	Chilcote 2001
<u>Age Notes</u>	average
Population	Joseph Creek
Years of Data, Length of Series	1974 - 2002, 29 years
Abundance Type	Total Live Count
Abundance References	Chilcote 2002
Abundance Notes	
Hatchery Reference	Chilcote 2002
Hatchery Notes	
Harvest Reference	Chilcote 2002
Harvest Notes	
Age Reference	Chilcote 2002
<u>Age Notes</u>	average
Population	Little Sheep Creek (Imnaha River) Hatch
Years of Data, Length of Series	1985 - 2002, 18 years
Abundance Type	Total Live Count
Abundance References	Chilcote 2002
Abundance Notes	
Hatchery Reference	Chilcote 2002

Hatchery Notes	
Harvest Reference	
Harvest Notes	
Age Reference	
<u>Age Notes</u>	
Population	Little Sheep Creek (Imnaha River) Wild
Years of Data, Length of Series	1985 - 2002, 18 years
Abundance Type	Total Live Count
Abundance References	Chilcote 2002
Abundance Notes	
Hatchery Reference	Chilcote 2002
Hatchery Notes	
Harvest Reference	Chilcote 2002
Harvest Notes	
Age Reference	Chilcote 2002
<u>Age Notes</u>	average
Population	Snake River A-run total
Years of Data, Length of Series	1985 - 2001, 17 years
Abundance Type	Total Live Count
Abundance References	Columbia River Basin Fish Mange Plan Tech. Adv Comm. 1996. All-Species Review; 1998-2000: spreadsheet sent from Peter Dygert & Enrique Patino, NMFS
Abundance Notes	
Hatchery Reference	Columbia River Basin Fish Mange Plan Tech. Adv Comm. 1996. All-Species Review; 1998-2000: spreadsheet sent from Peter Dygert & Enrique Patino, NMFS
Hatchery Notes	
Harvest Reference	Columbia River Basin Fish Mange Plan Tech. Adv Comm. 2002: spreadsheet sent from Henry Yuen, USFWS
Harvest Notes	
Age Reference	Columbia River Basin Fish Mange Plan Tech. Adv Comm. 2002: spreadsheet sent from Henry Yuen, USFWS
<u>Age Notes</u>	yearly

Population	Snake River B-run total
Years of Data, Length of Series	1985 - 2001, 17 years
Abundance Type	Total Live Count
Abundance References	Columbia River Basin Fish Mange Plan Tech. Adv Comm. 1996. All-Species Review; 1998-2000: spreadsheet sent from Peter Dygert & Enrique Patino, NMFS
Abundance Notes	Columbia River Basin Fish Mange Plan Tech. Adv Comm. 1996. All-Species Review; 1998-2000: spreadsheet sent from Peter Dygert & Enrique Patino, NMFS
Hatchery Notes	Columbia River Basin Fish Mange Plan Tech. Adv Comm. 2002: spreadsheet sent from Henry Yuen, USFWS
Harvest Notes	Columbia River Basin Fish Mange Plan Tech. Adv Comm. 2002: spreadsheet sent from Henry Yuen, USFWS
Age Reference	Yuen, USFWS
Age Notes	yearly
Population	Tucannon River
Years of Data, Length of Series	1987 - 2001, 13 years
Abundance Type	Total Live Count
Abundance References	Gallinat, et al. 2001, Mark Shuck, WDFW 2001 estimate
Abundance Notes	Gallinat, et al. 2001
Hatchery Notes	Columbia River Basin Fish Mange Plan Tech. Adv Comm. 2002: spreadsheet sent from Henry Yuen, USFWS
Harvest Notes	Gallinat, et al. 2001
Age Reference	average
Age Notes	
Population	Wallowa River (GR)
Years of Data, Length of Series	1965 - 1996, 31 years
Abundance Type	Redds per Mile
Abundance References	Streamnet: trend 54572
Abundance Notes	
Hatchery Reference	

Hatchery Notes	
Harvest Reference	
Harvest Notes	
Age Reference	
<u>Age Notes</u>	
Population	Asotin Creek
Years of Data, Length of Series	1986 - 2001, 13 years
Abundance Type	Expanded Redd Count
Abundance References	Mark Schuck, WDFW (Feb. 2003)
Abundance Notes	
Hatchery Reference	
Hatchery Notes	
Harvest Reference	
Harvest Notes	
Age Reference	
<u>Age Notes</u>	
 <b>Upper Columbia Steelhead</b>	
Population	Above Wells Dam
Years of Data, Length of Series	1976 - 2001, 26 years
Abundance Type	Total Live Count
Abundance References	QAR - Cooney (2001)
Abundance Notes	
Hatchery Reference	Douglas PUD - Wells Dam broodstock sampling
Hatchery Notes	
Harvest Reference	QAR - Cooney (2001) TAC mainstem, WDFW trib. Rates
Harvest Notes	
Age Reference	Cooney (2001) WDFW - Priest Rapids Steelhead sampling program (Brown, 1995, WDFW annual update memos)
<u>Age Notes</u>	yearly
Population	Wenatchee + Entiat Rivers
Years of Data, Length of Series	1976 - 2001, 26 years

Abundance Type	Total Live Count
Abundance References	QAR - Cooney (2001)
Abundance Notes	Cooney (2001) WDFW - Priest Rapids Steelhead sampling program (Brown, 1995, WDFW annual update memos)
Hatchery Reference	
Hatchery Notes	
Harvest Reference	QAR - Cooney (2001) TAC mainstem, WDFW trib. Rates
Harvest Notes	
Age Reference	Cooney (2001) WDFW - Priest Rapids Steelhead sampling program
Age Notes	yearly
Population	Methow River
Years of Data, Length of Series	1976 - 2001, 26 years
Abundance Type	Total Live Count
Abundance References	QAR - Cooney (2001), 1999-2001 B.
Abundance Notes	
Hatchery Reference	Douglas PUD - Wells Dam broodstock sampling
Hatchery Notes	
Harvest Reference	QAR - Cooney (2001) TAC mainstem, WDFW trib. Rates
Harvest Notes	
Age Reference	Cooney (2001) WDFW - Priest Rapids Steelhead sampling program (Brown, 1995, WDFW annual update memos)
Age Notes	yearly
<b><u>Middle Columbia Steelhead ESU</u></b>	
Population	John Day River, Upper North Fork
Years of Data, Length of Series	1977 - 2002, 26 years
Abundance Type	Redds per Mile
Abundance References	Chilcote 2001
Abundance Notes	updated spreadsheets from M. Chilcote, ODFW -2002
Hatchery Reference	12 ESU's data file
Hatchery Notes	
Harvest Reference	Chilcote 2002
Harvest Notes	

Age Reference	Chilcote 2001
Age Notes	average
Population	John Day River, Middle Fork
Years of Data, Length of Series	1974 - 2001, 28 years
Abundance Type	Redds per Mile
Abundance References	Chilcote 2001
Abundance Notes	updated spreadsheets from M. Chilcote, ODFW -2002
Hatchery Reference	12 ESU's data file
Hatchery Notes	
Harvest Reference	Chilcote 2002
Harvest Notes	
Age Reference	Chilcote 2001
Age Notes	average
Population	Deschutes River
Years of Data, Length of Series	1978 - 2002, 25 years
Abundance Type	Dam Count (Sherars)
Abundance References	Chilcote 2002
Abundance Notes	
Hatchery Reference	Chilcote 2002
Hatchery Notes	
Harvest Reference	Chilcote 2002
Harvest Notes	
Age Reference	Chilcote 2001
Age Notes	average
Population	Fifteenmile Creek (winter)
Years of Data, Length of Series	1964 - 2001, 24 years
Abundance Type	Redds per Mile
Abundance References	Streamnet
Abundance Notes	No annual sampling, assumed natural returns
Hatchery Reference	Chilcote 2001
Hatchery Notes	
Harvest Reference	

	Harvest Notes	Chilcote 2001 average
	Age Reference	Chilcote 2001 average
	Age Notes	Chilcote 2001 average
Population		
Years of Data, Length of Series		John Day River, Lower Mainstem
Abundance Type		1965 - 2002, 37 years
Abundance References		Redds per Mile
Abundance Notes		Chilcote 2001
Hatchery Reference		updated spreadsheets from M. Chilcote, ODFW -2002
Hatchery Notes		Chilcote 2001
Harvest Reference		Chilcote 2002
Harvest Notes		Chilcote 2001
Age Reference		Chilcote 2001 average
Age Notes		Chilcote 2001 average
Population		John Day River, Upper Mainstem
Years of Data, Length of Series		1974 - 2002, 29 years
Abundance Type		Total Live Count
Abundance References		Chilcote 2002
Abundance Notes		Chilcote 2002
Hatchery Reference		Chilcote 2002
Hatchery Notes		Chilcote 2001
Harvest Reference		Chilcote 2001 average
Harvest Notes		Shitike Creek (Deschutes)
Age Reference		1976 - 2002, 26 years
Age Notes		Redds per Mile
Population		updated spreadsheets from M. Chilcote, ODFW -2002
Years of Data, Length of Series		
Abundance Type		
Abundance References		
Abundance Notes		
Hatchery Reference		
Hatchery Notes		

Harvest Reference	Used Deschutes R ages
Harvest Notes	average
Age Reference	
Age Notes	
Population	John Day River, South Fork
Years of Data, Length of Series	1974 - 2002, 29 years
Abundance Type	Redds per Mile
Abundance References	Chilcote 2001
Abundance Notes	updated spreadsheets from M. Chilcote, ODFW -2002
Hatchery Reference	Chilcote 2001
Hatchery Notes	
Harvest Reference	Chilcote 2002
Harvest Notes	
Age Reference	Chilcote 2001
Age Notes	average
Population	Touchet River
Years of Data, Length of Series	1987 - 2001, 13 years
Abundance Type	Total Live Count
Abundance References	WDFW 1994, 1995, Bumgarner 2002 (1996-2001)
Abundance Notes	
Hatchery Reference	Streamnet: Touchet R natural (180065) divided by total (180065 + 180002)
Hatchery Notes	
Harvest Reference	Mainstem Harvest: T.A.C. spreadsheet, Tributary harvest: WDFW spreadsheet from Bob Leeland 05/24/2002
Harvest Notes	
Age Reference	
Age Notes	average
Population	Umatilla River
Years of Data, Length of Series	1966 - 2002, 35 years
Abundance Type	Total Live Count
Abundance References	Streamnet (1966-2000), Umatilla Tribal Fisheries 2002 (2001)
Abundance Notes	

Hatchery Reference	Chilcote 2002
Hatchery Notes	Chilcote 2002
Harvest Reference	Chilcote 2002
Harvest Notes	Chilcote 2002
Age Reference	Chilcote 2002
Age Notes	average
Population	John Day River, Lower North Fork
Years of Data, Length of Series	1976 - 2002, 27 years
Abundance Type	Redds per Mile
Abundance References	Chilcote 2001
Abundance Notes	updated spreadsheets from M. Chilcote, ODFW -2002
Hatchery Reference	Chilcote 2002
Hatchery Notes	Chilcote 2002
Harvest Reference	Chilcote 2002
Harvest Notes	Chilcote 2002
Age Reference	Chilcote 2002
Age Notes	average
Population	Walla Walla River
Years of Data, Length of Series	1993 - 2000, 8 years
Abundance Type	Total Live Count
Abundance References	ODFW 1998, Duke 2002 (1999-2001)
Abundance Notes	Chilcote 2001
Hatchery Reference	Chilcote 2001
Hatchery Notes	Chilcote 2001
Harvest Reference	Chilcote 2001
Harvest Notes	Chilcote 2001
Age Reference	Chilcote 2001
Age Notes	average
Population	Warm Springs National Fish Hatchery
Years of Data, Length of Series	1980 - 1999, 20 years
Abundance Type	Total Live Count
Abundance References	Chilcote 2001

Abundance Notes	Chilcote 2001
Hatchery Reference	
Hatchery Notes	
Harvest Reference	Chilcote 2001
Harvest Notes	
Age Reference	Chilcote 2001
<u>Age Notes</u>	average
Population	Yakima River
Years of Data, Length of Series	1980 - 2001, 23 years
Abundance Type	Total Live Count
Abundance References	From WDFW Spreadsheet 06/12/2002
Abundance Notes	
Hatchery Reference	
Hatchery Notes	
Harvest Reference	
Harvest Notes	
Age Reference	Table 4-3, Biological Assessment, Yakima Operations and Maintenance, Upper Columbia Area Office, BR , Aug. 2000
<u>Age Notes</u>	From WDFW Spreadsheet 06/12/2002
Population	Klickitat River
Years of Data, Length of Series	1990 - 2002, 9 years
Abundance Type	Redd Count
Abundance References	From Rolf Evenson, YIN Fisheries Biologist
Abundance Notes	
Hatchery Reference	
Hatchery Notes	
Harvest Reference	No recent year data available
Harvest Notes	
Age Reference	
<u>Age Notes</u>	

### **Lower Columbia River Steelhead ESU**

Population	Hood River summer-run steelhead
Years of Data, Length of Series	1992 - 2000, 9 years
Abundance Type	Dam/weir count
Abundance References	Gorman, Leah. 2001.
Abundance Notes	Dam counts at Powerdale dam
Hatchery Reference	Gorman, Leah. 2001.
Harvest Reference	No Harvest Data Available.
Age Reference	Gorman, Leah. 2001.
Age Notes	Repeat % total ranged from 2% to 10%.
Population	Kalama River summer-run steelhead
Years of Data, Length of Series	1977 - 2003, 27 years
Abundance Type	Trap Count
Abundance References	Rawding, Dan (WDFW). 2002a.
Abundance Notes	Trap count plus correction estimate for jumpers
Hatchery Reference	Rawding, Dan (WDFW). 2002a.
Hatchery Notes	Work done at RM 10 above the two hatcheries to minimize handle of hatchery fish. Substantial rearing may occur below; trapping takes place during spring
Harvest Reference	Rawding, Dan (WDFW). 2002a.
Age Reference	Rawding, Dan (WDFW). 2002a.
Age Notes	From 1998 forward no scales have been aged and mean ages are used for these years
Population	Washougal River summer-run steelhead
Years of Data, Length of Series	1986 - 2003, 18 years
Abundance Type	Index
Abundance References	WDFW. 1997. Rawding 2002a
Hatchery Reference	No Hatchery Data.
Harvest Reference	No Harvest Data Available.
Age Reference	Busby et al.1996; Chilcott, M. W. 2001; Hulett et al. 1995.
Age Notes	Generic sum age structure

Population	Wind River summer-run steelhead
Years of Data, Length of Series	1989 - 2003, 15 years
Abundance Type	Mark recapture
Abundance References	Rawding, Dan (WDFW). 2001b; Rawding 2002a.
Abundance Notes	Estimates made from mark-recapture from trap efficiency method. Adult trap at Shiperd Falls but adult population is estimate by M-R, since fish jump the falls. Not able to differentiate winter and summer-run steelhead smolts
Hatchery Reference	Rawding, Dan (WDFW). 2001b.
Harvest Reference	Rawding, Dan (WDFW). 2001b.
Age Reference	Rawding, Dan (WDFW). 2001b.
Population	Clackamas River winter-run steelhead
Years of Data, Length of Series	1958 - 2001, 44 years
Abundance Type	Dam/weir count
Abundance References	Cramer, Doug. 2002a.
Abundance Notes	Abundance data delivered via Kathryn Kostow, Or Dept of Fish and Wildlife
Hatchery Reference	Cramer, Doug. 2002a.
Hatchery Notes	Pre-1997 Wild Fraction determined by run timing; all fish counted on or after March 1 assumed to be Wild. Additional reference for 1997-2001 from Doug Cramer, PG; have #'s for wild and hatchery fish as of 1996-1997 run; all winter steelhead trapped and identified as wild or hatchery
Harvest Reference	ODFW 1999. Personal Communication. Personal communications for reconstructed run year estimates from punch cards for steelhead, 1956-1970
Age Reference	Busby et al.1996; Chilcote, M.W. 2001; Hulett et al. 1995.
Age Notes	Generic sum age structure
Population	Upper Cowlitz, Cispus and Tilton winter-run steelhead
Years of Data, Length of Series	2002, 1 year
Abundance Type	Dam/weir count
Abundance References	Serl and Morrill 2002
Abundance Notes	Abundance data delivered via Kathryn Kostow, Or Dept of Fish and Wildlife
Population	East Fork Lewis River winter-run steelhead

Years of Data, Length of Series	1985 - 1994, 10 years
Abundance Type	Peak Count
Abundance References	Johnson, T.H. and R. Cooper. 1995.
Abundance Notes	Natural population only; East Fork Lewis River, trib to Lewis River from mile 0.0 to mile 41.8
Hatchery Reference	Busby et al. 1996. Status review of west coast steelhead from WA, ID, OR and California
Harvest Reference	No Harvest Data Available.
Age Reference	Busby et al. 1996; Chilcott, M.W. 2001; Hulett et al. 1995.
Population	Hood River summer-run steelhead
Years of Data, Length of Series	1992 - 2000, 9 years
Abundance Type	Dam/weir count
Abundance References	Gorman, Leah. 2001.
Abundance Notes	Dam counts at Powderdale dam
Hatchery Reference	Gorman, Leah. 2001.
Harvest Reference	No Harvest Data Available.
Age Reference	Gorman, Leah. 2001.
Population	Kalama River winter-run steelhead
Years of Data, Length of Series	1977 - 2002, 26 years
Abundance Type	Trap Count
Abundance References	Rawding 2001b; Rawding 2002a.
Abundance Notes	Trap count plus correction estimate for jumpers
Hatchery Reference	Rawding 2001b.
Hatchery Notes	Work done at RM 10 above the two hatcheries to minimize handle of hatchery fish. Substantial rearing may occur below; trapping takes place during spring
Harvest Reference	Leland 2003.
Age Reference	Rawding 2001b
Age Notes	From 1998 forward no scales have been aged and mean ages are used for these years
Population	North Fork Toutle River winter-run steelhead
Years of Data, Length of Series	1989 - 2002, 14 years
Abundance Type	Total from redd count

Abundance References	Rawding 2001b; Rawding 2002a.
Abundance Notes	100% trap count
Hatchery Reference	Rawding 2001b.
Harvest Reference	Rawding 2002a.
Age Reference	Rawding 2001b.
Population	Sandy River winter-run steelhead
Years of Data, Length of Series	1978 - 2001, 24 years
Abundance Type	Dam/weir count
Abundance References	Cramer, Doug. 2002.
Abundance Notes	Dam counts made at Marmot Dam
Hatchery Reference	Chilcote, Mark. 1998.
Hatchery Notes	Used average hatchery fraction from 1978-1997 for years 1998-2001.
Harvest Reference	Berry, R.L. 1978.
Harvest Notes	Natural population catch determined by multiplying harvest by wild fraction
Age Reference	Busby et al.1996; Chilcote, Mark. 1998; Hulett et al. 1995.
Age Notes	Generic winter age structure
Population	South Fork Toutle River winter-run steelhead
Years of Data, Length of Series	1981 - 2002, 19 years
Abundance Type	Redd Surveys
Abundance References	Leland 2003; Rawding 2001b; Rawding 2002a.
Abundance Notes	Winter steelhead in S. Fork Toutle River are by redd surveys from March 15 to May 31. Redd surveys assume that you see 100% of the redds, only wild steelhead spawn after March 15, sex ratio is 1:1, and each redd represents 0.8 females. Assumed 2% stray rate
Hatchery Reference	Rawding 2001b.
Harvest Reference	Rawding 2001b.
Age Reference	Rawding 2001b.
Age Notes	Applied Kalama estimates to S. Fork Toutle River. Pooled ages 6 and 7 into age 6 to increase r/s sample size.

Population	Washougal River winter-run steelhead
Years of Data, Length of Series	1991 - 2002, 5 years
Abundance Type	Redd index
Abundance References	Leland 2003; WDFW 1993.
Hatchery Reference	Leland 2003; WDFW 1993.
Hatchery Notes	Reports little hatchery impact
Harvest Reference	No Harvest Data Available
Age Reference	Busby et al. 1996; Chilcote, M.W. 2001; Hulett et al. 1995.
Age Notes	Generic winter age structure
Population	Coweeeman River winter-run steelhead
Years of Data, Length of Series	1987 - 2002, 16 years
Abundance Type	Redd Surveys
Abundance References	Leland 2003; Rawding 2001b; Rawding 2002a.
Abundance Notes	Winter steelhead estimate in the Coweeeman River are by redd surveys from Mar 15 to May 31. Redd surveys assume that you see 100% of the redds, only wild steelhead spawn after March 15, sex ratio is 1:1, and each redd represents 0.8 females.
Hatchery Reference	Leland 2003; Rawding 2001b.
Hatchery Notes	Data on hatchery fraction for 1987-1989 were provided by Leland (2003), estimate for 1990-2002 based on estimate from Rawding of 50% hatchery.
Harvest Reference	Leland 2003. Rawding 2001b.
Age Reference	Rawding 2001b.
Age Notes	Only age structure data is for winter-run in N. Fork Toutle and Kalama Rivers, and summer-run in the Kalama. Age structure is very similar in Toutle and Kalama River winter-run. Toutle River has less repeats 5.3% to 8.9% possibly because kelts must pass through PVC tubes on the Sediment Dam, which negatively impacts their survival. Rawding applied the Kalama River winter-run to the Coweeeman and S. F. Toutle Rivers populations.
Population	East Fork Lewis River summer-run steelhead
Years of Data, Length of Series	1996 - 2003, 8 years
Abundance Type	snorkel survey
Abundance References	Rawding, Dan. 2002a.

Hatchery Reference	Rawding, Dan. 2002a.
Harvest Reference	Rawding, Dan. 2002a.
Age Reference	Rawding, Dan. 2002a.
<b><u>Upper Willamette River Steelhead ESU</u></b>	
Population	Calapooia River winter-run steelhead
Years of Data, Length of Series	1980 - 2000, 21 years
Abundance Type	Redd Count
Abundance References	Anonymous 1995; Anonymous 1997; Hunt, Wayne. 1999.
Abundance Notes	Data from StreamNet
Harvest Reference	Chilcote, Mark. 2001
Hatchery Reference	Chilcote, Mark. 2001
Population	South Santiam River winter-run steelhead
Years of Data, Length of Series	1983 - 2000, 18 years
Abundance Type	Redd Count
Abundance References	Anonymous 1995; Anonymous 1997
Abundance Notes	Data from StreamNet
Harvest Reference	Chilcote, Mark. 2001.
Hatchery Reference	Chilcote, Mark. 2001
Population	North Santiam River winter-run steelhead
Years of Data, Length of Series	1983 - 2000, 18 years
Abundance Type	Redd Count
Abundance References	Anonymous 1998; Anonymous 1998.
Abundance Notes	Data from StreamNet
Harvest Reference	Chilcote, Mark. 2001.
Hatchery Reference	Chilcote, Mark. 2001
Population	Molalla River winter-run steelhead
Years of Data, Length of Series	1980 - 2000, 21 years

Abundance Type	Redd Count
Abundance References	Anonymous 1997; Hunt, Wayne. 1999.
Harvest Reference	Chilcote, Mark. 2001.
Hatchery Reference	Chilcote, Mark. 2001
Population	South Santiam River (Foster Dam)
Years of Data, Length of Series	1973 - 2000, 28 years
Abundance Type	Total Live Fish
Abundance References	ODFW 1990; Anonymous 1997; Anonymous 1994; Hunt, Wayne. 1999.
Harvest Reference	Chilcote, Mark. 2001.
Population	Willamette Falls Dam winter-run steelhead
Years of Data, Length of Series	1971 - 2002, 32 years
Abundance Type	Dam/weir count
Abundance References	Kostow, Kathryn. 2002.